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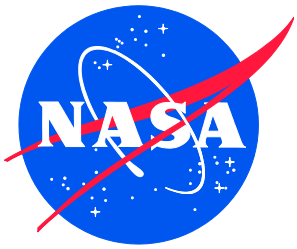

Orion – Super Koropon® Torque/Tension Report

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July 2012

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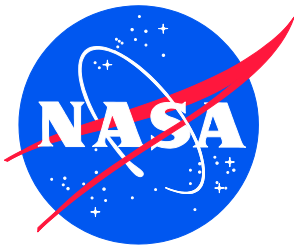

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Acronyms

CRES	Corrosion Resistant Steel
DFL	Dry Film Lubricant
EXHD	Extra Heavy Duty
GSFC	Goddard Space Flight Center
HD	Heavy Duty
IPA	Isopropyl Alcohol
LD	Light Duty
LabVIEW™	Laboratory Virtual Instrumentation Engineering Workbench
LW	Light Weight
NSCKN	NASA Safety Center Knowledge Now

1.0 Test Objectives

The primary objective of this testing was to obtain torque tension data for the use of Super Koropon® Primer Base which was proposed for use on the Orion project. This compound is a corrosion inhibitor/sealer used on threaded fasteners and inserts as specified per NASA/JSC PRC-4004, *Sealing of Joints and Faying Surfaces*. Some secondary objectives of this testing, were to identify the effect on torque coefficient of the following variables:

- The effect of multiple cycling of inserts on torque coefficient,
- The effect of fastener and washer replacement in multiple cycling of inserts on torque coefficient,
- The affect of use of multiple lot and or multiple type inserts of a given size on torque coefficient,
- The effect on torque coefficient of isopropyl alcohol (IPA) ultrasonic cleaning of all hardware vs. use in as received, un-cleaned condition, and
- The effect of multiple cycling of locking inserts on "running torque".

Two different fasteners sizes, #10-32 and 1/4-28 A286 corrosion resistant steel (CRES) (160 ksi ult) were tested at the Goddard Space Flight Center (GSFC). The fasteners were torqued into three different types of A-286 locking Keenserts®, Light Weight (LW), Heavy Duty (HD) and Extra Heavy Duty (EXHD). In addition to the different type inserts, two different lot numbers for each size and type were also tested to determine the effect on the torque tension relationship of these variables.

To establish a baseline, the fastener-insert combinations were initially tested in the "un-lubricated dry" conditions. The follow on testing was then performed in the "wet lubricated" condition with the lubricant being Super Koropon® Primer Base without its curing agent so that multiple torque cycles could be applied.

Also, to provide additional variables, one half of all the test hardware (fasteners, inserts and washers) were cleaned ultrasonically using IPA to determine the effect of cleanliness on the torque tension relationship.

2.0 Hardware

The fasteners and washers tested were made of A286 Stainless Steel. They are specified in Table 2.1. The Keenserts® tested are specified in Table 2.2.

Table 2.1. A286 stainless steel fasteners and washers tested.

	Fasteners	Washers
1	#10-32 Hex Head A286 NAS6703U12	LMC21D5AC3C/A286 CS
2	1/4-28 Hex Head A286 NAS6704U12	LMC21D5AC3C/A286 CS

Table 2.2. Keenserts® tested.

		HD	EXHD	LW
1	#10-32	MS51831CA201L	MS51832CA201L	MS51830CA201L
2	1/4-28	MS51831CA202L	MS51832CA202L	

It is noted that DFL was applied by the manufacturer to all Keensert® threads and this lubrication was not removed by ultrasonic cleaning. The inserts were installed into a 0.75-inch-thick 6061-T651 aluminum test plate. Countersunk washers were used to insure sufficient clearance for the fastener head to shank transition radius.

3.0 Test Equipment

For this testing, a bolt-load measuring system consisting of three Omega miniature compression load cells was used. This system was previously used for small fastener testing at GSFC. Different size bushings were fabricated of high-strength steel to provide the proper interface clearance for each different size fastener. Figure 3.1 illustrates the equidistant load cell configuration from a center bushing used for fastener insertion into the test plate and insert interface.

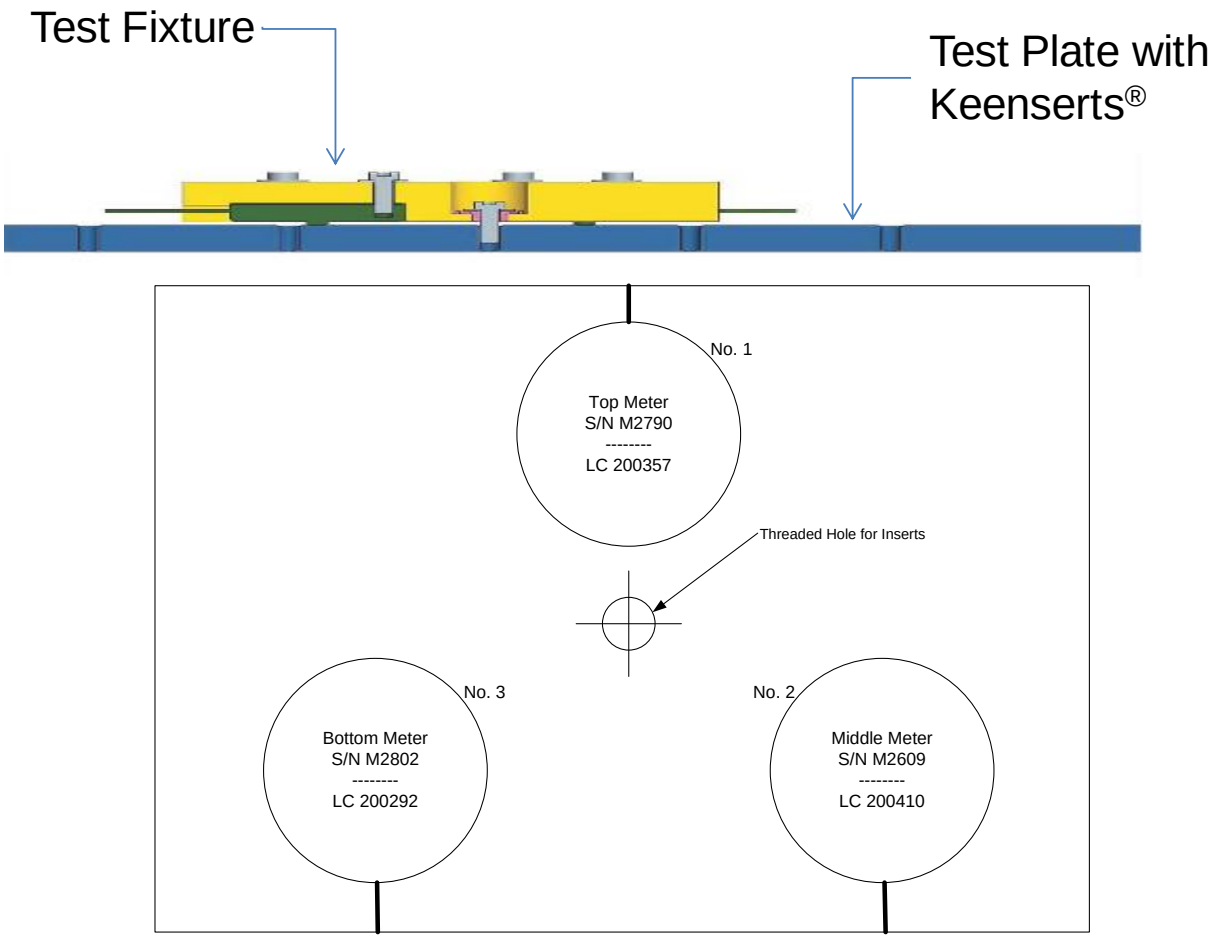


Figure 3.1. Load cell and test fixture arrangement.

The output of applied torque and compression from calibrated load cells and digital torque wrench was integrated into Code 549 recently upgraded bolt analyzer system shown in Figure 3.2.

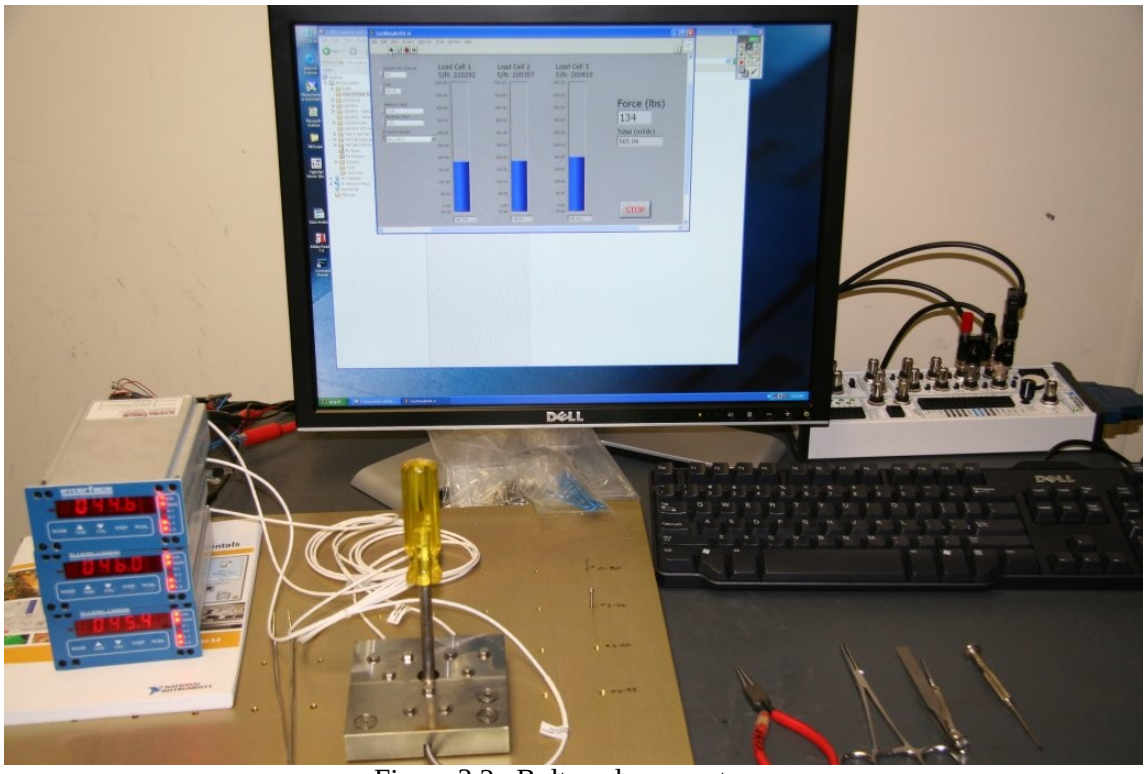


Figure 3.2. Bolt analyzer system.

The bolt analyzer system simultaneously records both the tensile bolt load and applied torque. The various components of this system are as follows:

1. Three Omega Load Cells; Model LCGD-1K
   a. ID: Top S/N LC200357
   b. ID: Bottom S/N LC200292
   c. ID: Middle S/N LC200410
2. Three Interface Advanced Force Measurement Load Indicators; Model 9800-000-1
   a. ID: Top S/N M2790
   b. ID: Bottom S/N
   c. ID: Middle S/N M2832
3. Digital Torque Wrench
   a. ID: S/N 9437 – 200 in-lb calibrated capacity
   b. ID: S/N 9644 – 300 in-lb calibrated capacity
4. Signal conditioning box
5. Laptop PC running LabVIEW™ (Laboratory Virtual Instrumentation Engineering Workbench), Version: 8.6

Prior to fastener testing, the load cells were calibrated in the B29 Tinius Olsen as shown in Figure 3.3. A typical load cell calibration data sheet is shown in Figure 3.4 and a digital torque-wrench calibration curve is shown in Figure 3.5.

Figure 3.3. B29 Tinius Olsen

Medium Bolt Tester Tinius Olsen Calibration Test : Configuration 1

Date 4/22/09 — ManTech Eng C. McLeod
Facility 60K LB TO — ManTech Tech W. Goodman
Configuration No. 1

Load	LabVIEW Readings (lb)					Diff	% Weight Distribution		
(lb)	Meter 1	Meter 2	Meter 3	Total	Comments	(lb)	Meter 1	Meter 2	Meter 3
0	-0.13	-0.08	-0.04	-0.25	Load increasing	-0.2	50.80	32.41	16.79
265	83.67	103.19	57.89	244.75	Load increasing	-20.3	34.19	42.16	23.65
510	170.52	210.22	115.45	496.19	Load increasing	-13.8	34.37	42.37	23.27
750	252.59	307.26	170.74	730.58	Load increasing	-19.4	34.57	42.06	23.37
1000	341.21	408.68	234.57	984.47	Load increasing	-15.5	34.66	41.51	23.83
1250	431.88	508.79	303.26	1243.93	Load increasing	-6.1	34.72	40.90	24.38
1500	516.38	600.36	370.13	1486.88	Load increasing	-13.1	34.73	40.38	24.89
1750	606.53	697.25	446.38	1750.16	Load increasing	0.2	34.66	39.84	25.51
2000	687.68	785.91	518.65	1992.24	Load increasing	-7.8	34.52	39.45	26.03
2250	776.32	882.98	600.00	2259.30	Load increasing	9.3	34.36	39.08	26.56
2500	860.26	976.14	677.03	2513.43	Load increasing	13.4	34.23	38.84	26.94
2800	955.56	1082.87	765.83	2804.26	Load increasing	4.3	34.08	38.62	27.31
3000	1020.85	1155.61	829.53	3005.99	Load increasing	6.0	33.96	38.44	27.60
2730	940.30	1061.47	748.30	2750.07	Load decreasing	20.1	34.19	38.60	27.21
2510	873.38	981.28	674.20	2528.87	Load decreasing	18.9	34.54	38.80	26.66
2260	791.39	892.35	591.59	2275.33	Load decreasing	15.3	34.78	39.22	26.00
2000	703.15	796.95	506.47	2006.57	Load decreasing	6.6	35.04	39.72	25.24
1750	620.35	707.48	431.06	1758.89	Load decreasing	8.9	35.27	40.22	24.51
1500	533.42	611.75	358.54	1503.71	Load decreasing	3.7	35.47	40.68	23.84
1245	446.37	515.71	289.48	1251.56	Load decreasing	6.6	35.67	41.21	23.13
1000	360.83	419.71	224.86	1005.40	Load decreasing	5.4	35.89	41.75	22.36
750	269.38	313.40	160.61	743.39	Load decreasing	-6.6	36.24	42.16	21.60
500	183.94	214.01	106.02	503.98	Load decreasing	4.0	36.50	42.46	21.04
250	90.62	105.65	51.21	247.48	Load decreasing	-2.5	36.62	42.69	20.69
0	0.74	0.08	0.22	1.04	Load decreasing	1.0	71.06	7.51	21.44
			Average Difference: Overall =			0.7			
			Average Difference: Increasing =			-4.9			
			Average Difference: Decreasing =			6.8			

Figure 3.4. A typical load cell calibration data sheet.

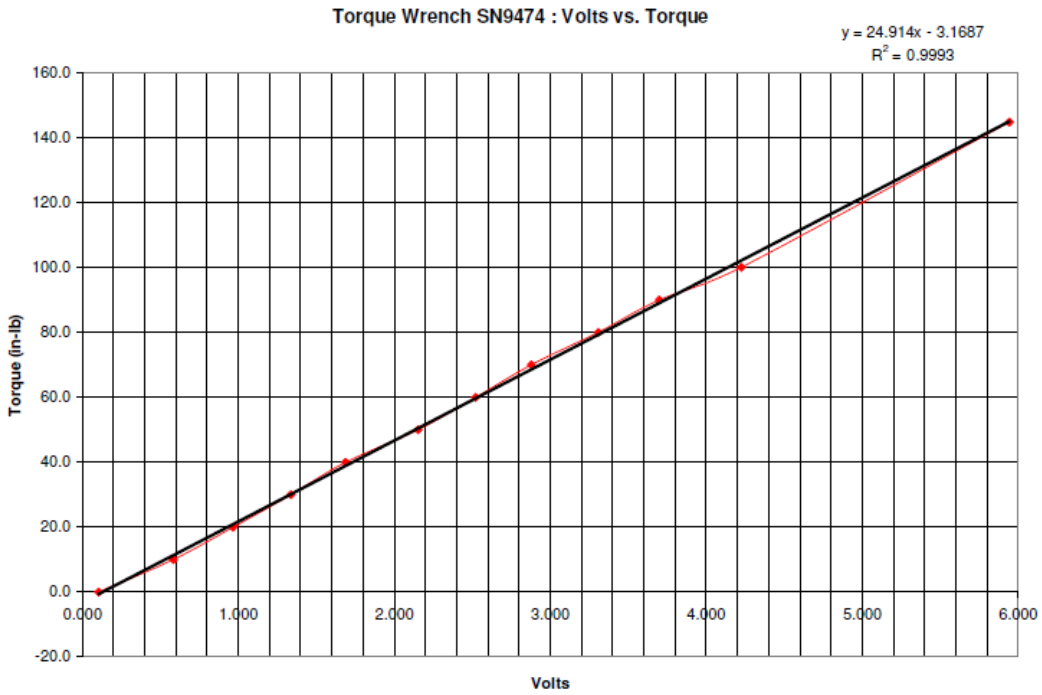


Figure 3.5. A digital torque-wrench calibration curve

4.0 Test Description

Prior to testing, one-half of all fasteners, inserts, and washers were ultrasonically cleaned in IPA and bagged, similar to flight. The bolt test fixture and test plate were also cleaned with IPA and clean room gloves were worn during test performance and when handling the test hardware.

Dry testing was performed first, followed by wet lubrication testing with Super Koropon®. For wet lubrication runs, the Super Koropon® (without activator) was applied to the upper and lower washer surfaces and to the underside of the fastener head. Application was by use of a dropper with four drops applied circumferentially to each washer and fastener surface. No Super Koropon® was applied directly to the threads, although some may have seeped into the threads during successive cycling. All surfaces were thoroughly cleaned with IPA after third and sixth cycles. The inserts were cycled six times with fasteners and washers replaced after the third cycle.

Torque tension data were recorded at specified intervals up to 65 percent of the fastener yield strength. This target preload level represents the standard preload specified for most flight hardware. The specified target preload and torque levels were as indicated in Table 4.1.

Table 4.1. Target preload levels.

Fastener Size	Diameter (in)	Pitch	Area (in^2)	Target Preload (lb) 65-percent Fty (160 Ftu/ 120 Fty)	Est. High Torque Dry (k = 0.23)	Est Low Torque Wet (k = 0.11)	No. of Turns for 1.5-dia. engagement
#10-32 UNF	0.19	32	0.0226	1765	77.1	36.9	9
1/4-28 UNF	0.25	28	0.0404	3154	181.4	86.74	10.5

Both torque and fastener preload were monitored continuously until the full preload was attained.

4.1 Test Sequence

Each fastener was cycled three times while each insert was cycled six times. A typical run log used for testing is shown in Figure 4.1.1. It includes run numbers and specific hardware and test conditions associated with that particular series of tests. It also specifies the target preload levels obtained and when the change out of fasteners and washers occurred. After three cycles into a given insert, a new washer and fastener were used for the next three cycles into the same insert. Each time a fastener and washer were replaced, the test plate and fixture interface were cleaned with IPA. All post-test fasteners and washers were bagged and tagged with their appropriate run numbers. The number of insertions in each insert was recorded and tracked to ensure that each insert was not cycled more than six times.

NESC Orion Torque/Tension Run Log

Date: 7/21/2009
Time: 2:00 PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.2, 20.1, 50.1
Temperature(ºF): 72.1
Humidity(%): 56.0

Tor Wrench Op: C. McLeod

Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4 Clean
Washer: LMC21D5AC3C

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA201L Dry	HD MS51831CA201L Wet	ExHD MS51832CA201L Dry	ExHD MS51832CA201L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
1	1,1	1	NAS6703U12	#10-32 x .75	1765	105			X		9474	100 in-lb	
2	1,1	2	NAS6703U12	#10-32 x .75	1765	81			X		9474	100 in-lb	
3	1,1	3	NAS6703U12	#10-32 x .75	1765	94			X		9474	100 in-lb	
				Change Bolt									
4	1,1	1	NAS6703U12	#10-32 x .75	1765	91			X		9474	100 in-lb	
5	1,1	2	NAS6703U12	#10-32 x .75	1765	104			X		9474	100 in-lb	
6	1,1	3	NAS6703U12	#10-32 x .75	1765	111			X		9474	100 in-lb	
				Change Bolt									
7	1,2	1	NAS6703U12	#10-32 x .75	1765	60			X		9474	100 in-lb	
8	1,2	2	NAS6703U12	#10-32 x .75	1765	64			X		9474	100 in-lb	
9	1,2	3	NAS6703U12	#10-32 x .75	1765	79			X		9474	100 in-lb	
				Change Bolt									
10	1,2	4	NAS6703U12	#10-32 x .75	1765	58			X		9474	100 in-lb	
11	1,2	5	NAS6703U12	#10-32 x .75	1765	65			X		9474	100 in-lb	
12	1,2	6	NAS6703U12	#10-32 x .75	1765	72			X		9474	100 in-lb	
				Change Bolt									

Figure 4.1.1. Typical run log used for testing.

Separate test plates were used for the wet and dry cases. The fastener torque was applied at a rate of approximately 6 rpm until the target load was reached. At the beginning of each day of testing, a set of test weights (5 lb, 10 lb, and 50 lb) were placed on the test fixture plate with the output recorded. This was done to ensure the stability of the torque-tension measuring system.

All testing was recorded in run logs with test plate and insert locations clearly identified. A typical test plate is shown in Figure 4.1.2 and the corresponding run log is shown in Figure 4.1.1. A complete set of Run Logs with test plate drawings are included with the test results in the Appendices. The temperature and humidity in the lab was recorded at the beginning and end of each day of testing.

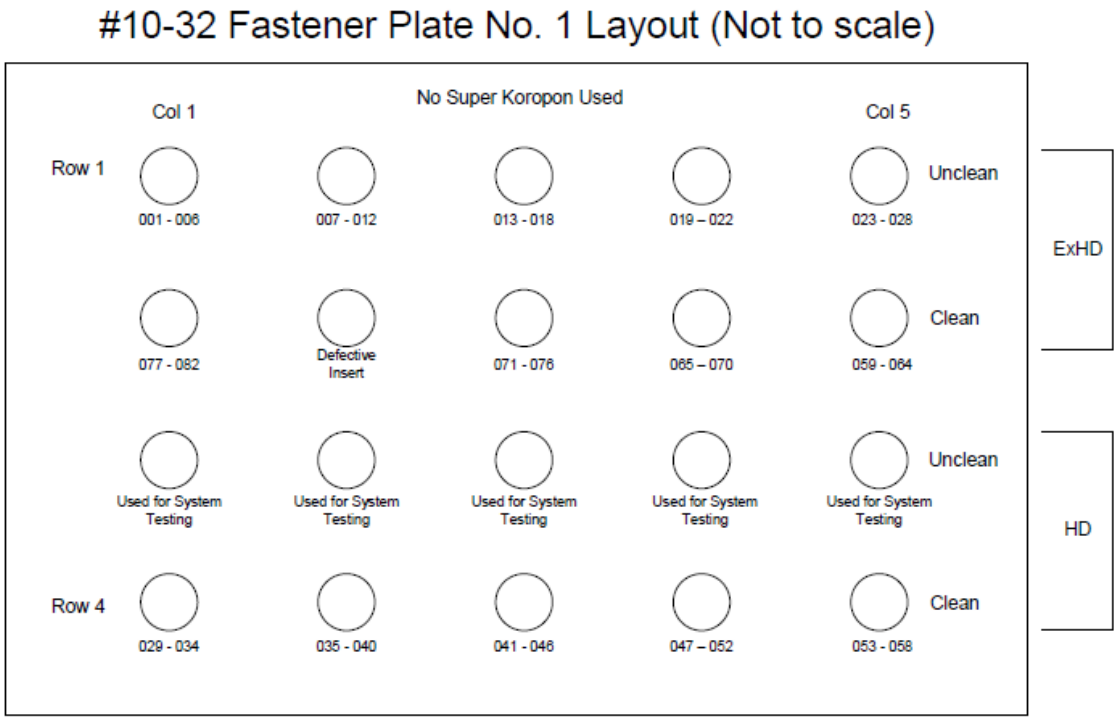


Figure 4.1.2. Typical test plate layout.

5.0 Test Results

As previously noted, each insert is cycled six times with fasteners and washers replaced after the third cycle. For wet, lubricated testing, Super Koropon® Primer Base (without activator) was applied at the washer and bolt-head interfaces. A full set of the torque-tension test data, including data plots, is included in the Appendices as follows:

Appendix A – Full set of #10-32 Torque Tension and Running Torque Plots for six cycles per insert, Excel® Torque Coefficient Data at 65 percent Pre Load, Test Plate Layouts and complete set of Run Logs.

Appendix B – Full set of 1/4-28 Torque Tension and Running Torque Plots for six cycles per insert, Excel® Torque Coefficient Data at 65 percent Pre Load, Test Plate Layouts and complete set of Run Logs.

Appendix C – Full set of #10-32 Torque Tension and Running Torque Plots for ten cycles per insert, Excel® Torque Coefficient Data at 65% Pre Load, Test Plate Layouts and complete set of Run Logs.

Appendix D – Full set of 1/4-28 Torque Tension and Running Torque Plots for ten cycles per insert, Excel® Torque Coefficient Data at 65% Pre Load, Test Plate Layouts and complete set of Run Logs.

The torque-tension data plots are presented in two formats as follows:

1. The cycle plots combine individual cycles (i.e., the "first cycle plot" combines all individual first cycles, the "second" combines all individual second cycles and so-forth) (see Figure 5.1). A total of six cycle plots are required per each set of data runs.
2. Torque-tension plots combine all six cycles for each specific insert on one plot (see Figure 5.2). The total number of plots for this sequence would equal the number of inserts tested.

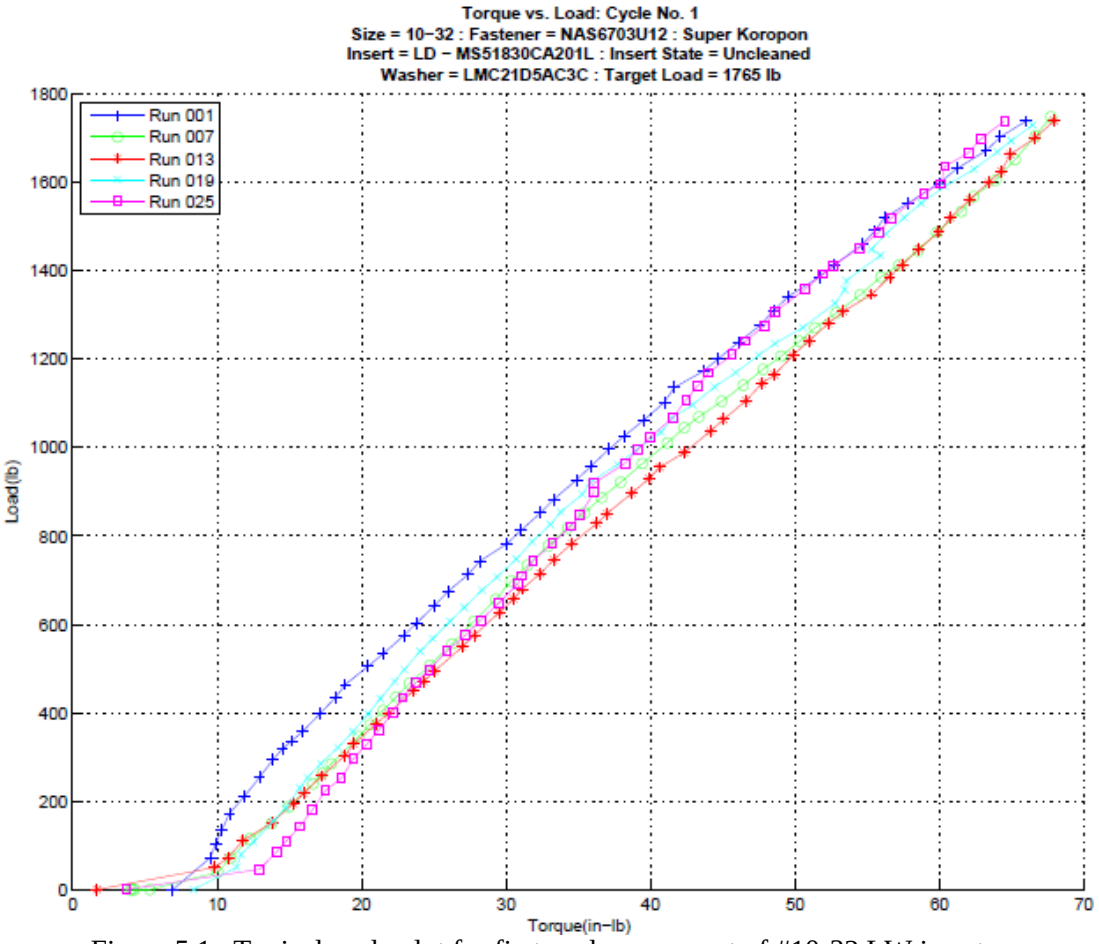


Figure 5.1. Typical cycle plot for first cycle on one set of #10-32 LW inserts.

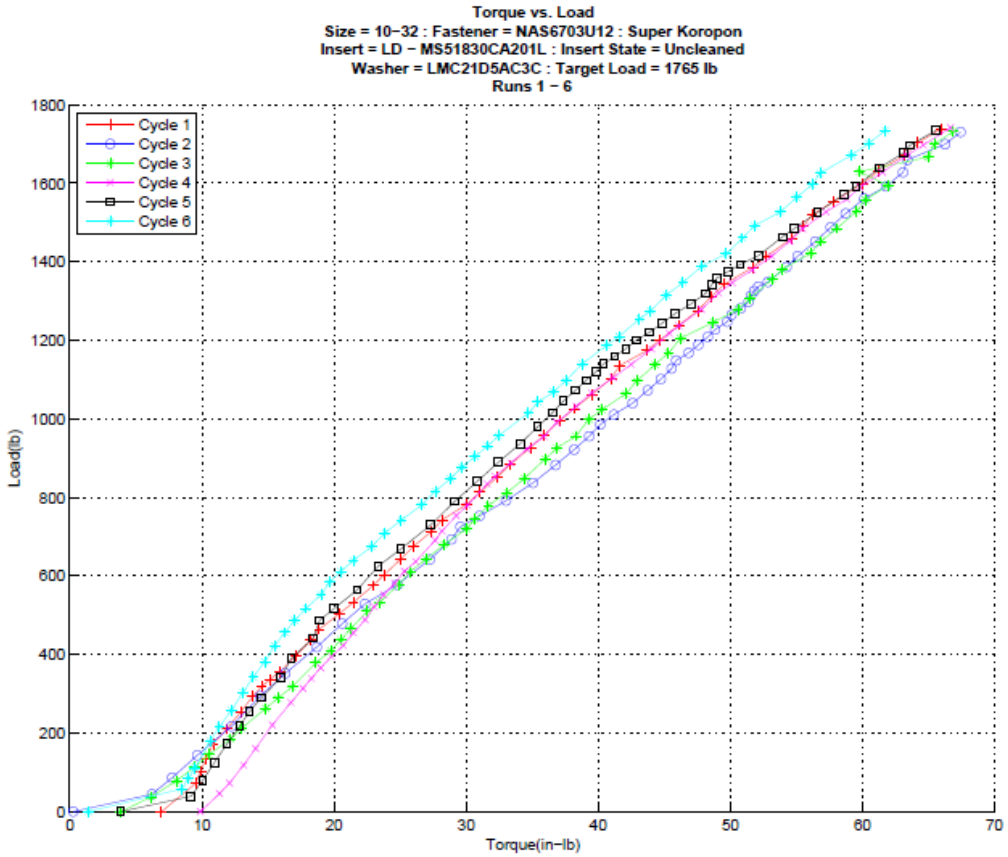


Figure 5.2. Torque-tension plot combining all six cycles.

A complete set of cycle and torque tension plots, including individual Excel® data files, for each data run has been uploaded to the NASA Safety Center Knowledge Now (NSCKN) website for reference.

5.1 Excel® Data Sheet Calculations at 65-percent Preload

The Excel® data sheet calculations, containing a summary of torque coefficients "K", at 65 percent yield for #10-32 and 1/4-28 fasteners and inserts are included in Appendices A and B. The measured friction coefficients "K" for all test runs are included in these calculations. The calculations are performed using single tailed B-basis and two tailed methods as follows:

- The sample base was segregated based on fastener size, type of insert and cleanliness. The typical sample sub-base consisted of n = 8 to 10 units or inserts. The mean, median and standard deviation was calculated for each "n" unit sub-base.
- Calculations were first performed on an individual lot and type insert basis.
- Calculations were performed again with all test runs combined to simulate multiple lot testing for a given size fastener.
- The values for Kmax and Kmin were calculated using statistical interval methods.
- Since each insert was cycled six times, the above properties were calculated for each cycle and then were used to determine the statistical tolerance interval for Kmax and Kmin using Excel® spreadsheet methods.

- The basis for these calculations was

    1. MIL-HDBK-5F Table 9.6.4.1 for one sided B-basis intervals.
    2. "Statistical Tolerance Intervals for a Normal Population", by Gerald Hahn, General Electric Company, for two sided intervals.

- The "Kmax-Kmin" interval based on the two-sided method was found to be slightly more conservative.

6.0 General Assumptions and Conclusions

The following generalized conclusions can be drawn based on the torque-tension test results to date:

- As-received "un-cleaned" hardware was found to have slightly lower friction coefficients for initial torque cycles (1 and 3) but had greater variation over all cycles 1–6.
- The calculated mean after repeated cycling was found to be essentially the same for cleaned and un-cleaned hardware.
- The friction coefficient results for various insert types, of the same size, were found not to differ significantly.
- Therefore, combining test results for HD, EXHD and Light Duty (LD) Keenserts® could be assumed equivalent to multiple lot testing.
- The same assumption could be made for combining cleaned and un-cleaned sample sets.
- Replacement of fasteners and washers in multiple cycling into a given insert is beneficial in reducing the torque coefficient variation.
- The calculated B-basis variance, i.e. Kmax-Kmin, was found to exceed slightly the measured variation shown in Table 6.1 and Figure 6.1.

Table 6.1. The measured difference in friction coefficients (i.e., Kmax-Kmin) for cleaned and un-cleaned inserts.

Un-cleaned #10-32 Fasteners and Inserts				IPA Cleaned Fasteners and Inserts		
Torque Cycle	Minimum	Maximum	Mean	Minimum	Maximum	Mean
1	0.201	0.285	0.256	0.225	0.279	0.241
2	0.211	0.303	0.272	0.257	0.309	0.280
3	0.221	0.368	0.316	0.311	0.368	0.328
4	0.229	0.300	0.259	0.245	0.321	0.256
5	0.244	0.367	0.303	0.281	0.367	0.301
6	0.277	0.368	0.330	0.324	0.367	0.353

The running torque was found to decrease markedly after initial cycles when preload is applied during each cycle.

6.1 Dry Test Results without use of Super Koropon® as Lubricant

A series of dry tests without Super Koropon® were first performed to establish a baseline for Orion testing. As previously noted, one-half of all fasteners, inserts, and washers were ultrasonically cleaned in IPA and the remaining hardware was tested in the as-received condition. The fastener threads and washer interface surfaces were not lubricated, but all inserts

had Dry Film Lubricant (DFL) applied to the threads by the manufacturer. A total of (14) #10-32 inserts were tested, 9 in the as- received un-cleaned condition and 5 were ultrasonically cleaned in IPA (see Figure 6.1.1). The measured difference in friction coefficients (i.e., Kmax- Kmin) for cleaned and un-cleaned inserts was as noted in Table 6.1.

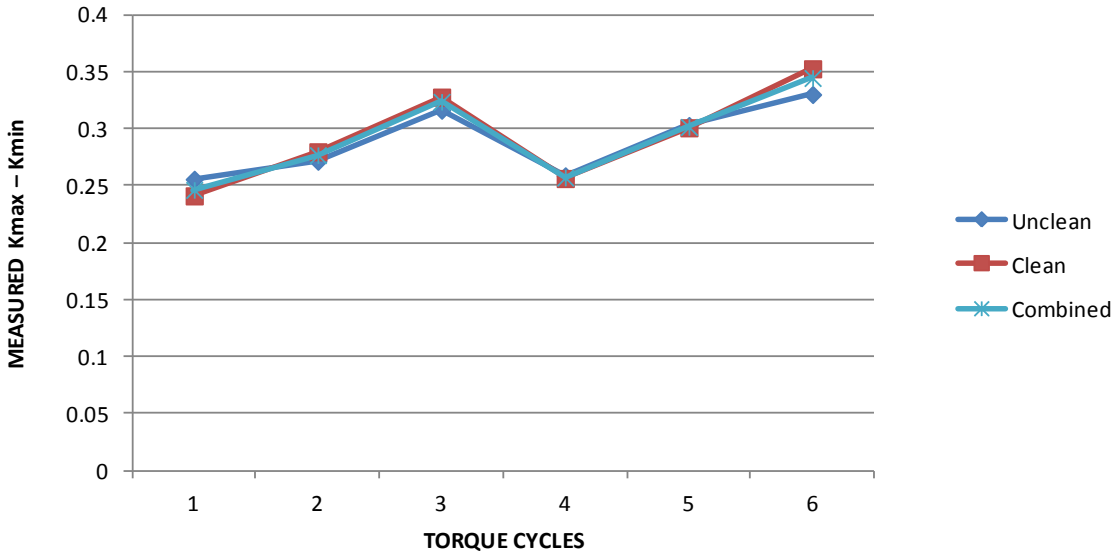


Figure 6.1.1. Plot of torque coefficients vs. cycles on dry un-lubricated #10-32 fasteners and inserts.

Test Results and observations:

- As noted in Table 6.1, the measured difference (i.e., Kmax-Kmin) was typically larger for the as-received un-cleaned specimens.
- However, there was little difference in the mean coefficients as shown in Figure 6.1.1.
- For the as received, un-lubricated fasteners, the friction coefficients increased with number of cycles on a given insert.
- After fastener and washer replacement on third cycles, the friction coefficients decreased to that of initial torque cycles.

Testing of un-lubricated 1/4-28 fasteners was aborted due to high friction coefficients and extreme galling of the washers and bolt-head interface surfaces. Results for total of four un-cleaned and two cleaned inserts are as noted in Tables 6.1.1 and 6.1.2, respectively.

Table 6.1.1. Results for as-received un-cleaned 1/4-28 fasteners and inserts.

Cycle-1	Cycle-2	Cycle-3	Cycle-4	Cycle-5	Cycle-6
0.302-0.441	0.375-0.457	0.421-0.449	0.368-0.414	0.354-0.481	0.389-0.521

Table 6.1.2. Results for IPA cleaned 1/4-28 fasteners and inserts.

Cycle-1	Cycle-2	Cycle-3	Cycle-4	Cycle-5	Cycle-6
0.38-0.431	0.455-0.470	0.479-0.484	0.426-0.461	0.563-0.569	0.567-0.553

It is noted that the severe galling and resulting high friction coefficients for the 1/4-28 fasteners was not experienced by similar testing performed at the University of Oakland, by Dr. Nassar.

The difference in results may be due to use of a torque tension machine by Dr. Nassar, whereas GSFC testing was performed by hand torque application, similar to that used in assembly of flight hardware.

6.2 Wet Test Results for Fasteners with Super Koropon® as Lubricant

Testing with Super Koropon® was performed to get an estimate of the torque tension relationship when using this compound during flight hardware assembly. In order to allow for multiple cycling of inserts, the Super Koropon® was applied without use of its curing agent. With Super Koropon® applied to the washer and bolt-head surfaces, the variation of friction coefficients (Kmin-Kmax) based on measured values at 65 percent preload are listed in Tables 6.2.1 and 6.2.2, respectively, for #10-32 fasteners and inserts.

Table 6.2.1. #10-32 measured friction coefficients (Kmin-Kmax) for as-received un-cleaned hardware.

Insert	Cycle-1	Cycle-2	Cycle-3	Cycle-4	Cycle-5	Cycle-6
MS51830CA201L(LD)	0.195-0.206	0.178-0.205	0.162-0.208	0.188-0.215	0.188-0.208	0.178-0.197
MS51831CA201L(HD)	0.216-0.261	0.215-0.254	0.197-0.247	0.239-0.268	0.238-0.257	0.222-0.298

Table 6.2.2. #10-32 measured friction coefficients (Kmin-Kmax) for IPA cleaned hardware.

Insert	Cycle-1	Cycle-2	Cycle-3	Cycle-4	Cycle-5	Cycle-6
MS51830CA201L(LD)	0.196-0.233	0.173-0.201	0.169-0.181	0.229-0.257	0.217-0.254	0.201-0.230
MS51831CA201L(HD)	0.206-0.237	0.207-0.233	0.198-0.232	0.233-0.241	0.217-0.263	0.194-0.248

Since each insert was cycled six times, the above measured (Kmin-Kmax) was based on a sample base equal to the total number of each type insert tested.

The mean torque coefficient vs. cycles plots for both #10-32 and 1/4-28 test hardware is shown in Figures 6.2.1 and 6.2.2.

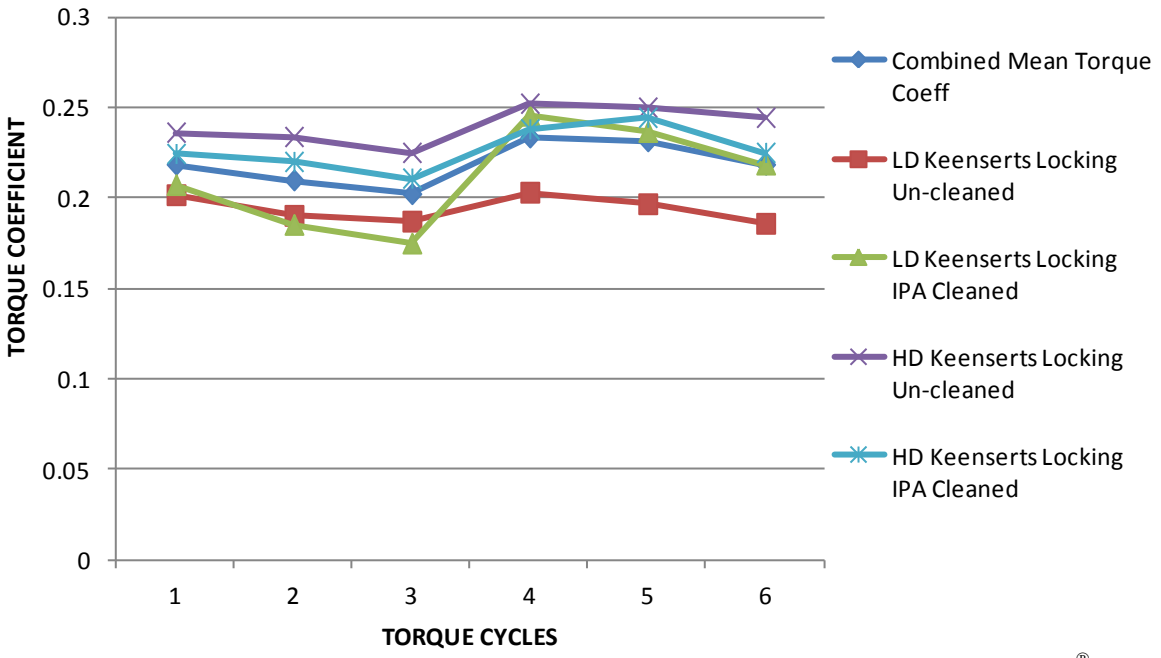


Figure 6.2.1. Mean torque coefficients vs. cycles for various #10-32 locking Keenserts®.

For #10-32 hardware in Figure 6.2.1, the following observations are made:

- The un- cleaned HD Keenserts® exhibited slightly higher friction coefficients than that of IPA cleaned hardware.
- The LD un-cleaned Keenserts® had the lowest friction coefficients but the cleaned units had the greatest variation per cycle.

The first cycle range of mean friction coefficients was observed to be from 0.20 to 0.23.

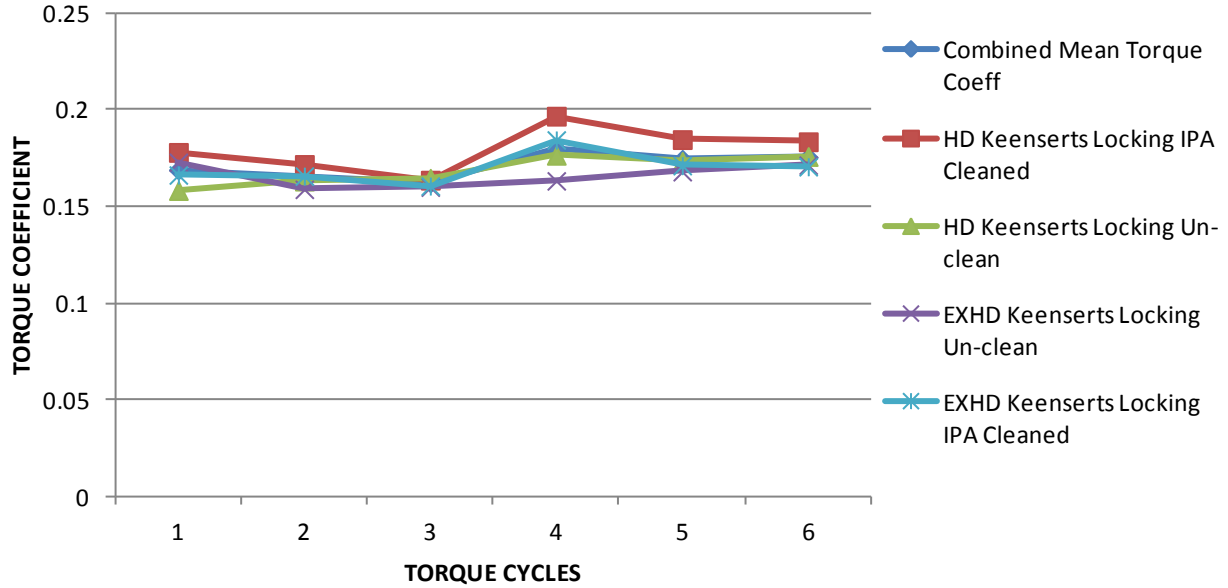


Figure 6.2.2. Mean torque coefficients vs. cycles for various 1/4-28 locking Keenserts®.

For 1/4-28 hardware in Figure 6.2.2, the following observations are made:

- The IPA cleaned HD Keenserts® exhibited slightly higher friction coefficients than that of un-cleaned hardware.
- The HD un-cleaned Keenserts® had the lowest friction coefficients and variation per cycle but the cleaned units had the greatest variation per cycle.
- The first cycle range of mean friction coefficients was observed to be from 0.16 to 0.18, which was lower than that observed for the #10-32 units.

Combining all insert types, cleaned, un-cleaned, and different lot numbers into one data set for #10-32 and 1/4-28 fasteners, the statistical B-basis tolerance interval (with 95-percent confidence, for 95 percent of the population) was calculated as shown in Tables 6.2.3 and 6.2.4, respectively. Figures 6.2.3 and 6.2.4 show the torque coefficients and percent variance vs. cycles plots for #10-32 and 1/4-28 lubricated with Super Koropon®.

Table 6.2.3. Combined data set for #10-32 fasteners into locking Keenserts®

Cycle	Mean	Median	STDA	Kmin	Kmax	Variance, percent
1	0.218	0.220	0.020	0.180	0.257	17.7
2	0.210	0.210	0.025	0.161	0.258	23.1
3	0.202	0.200	0.025	0.153	0.251	24.4
4	0.233	0.239	0.022	0.190	0.277	18.7
5	0.231	0.240	0.026	0.180	0.282	22.0
6	0.218	0.225	0.030	0.159	0.277	26.9

Table 6.2.4. Combined data set for 1/4-28 fasteners into locking Keenserts®

Cycle	Mean	Median	STDA	Kmin	Kmax	Variance, percent
1	0.169	0.165	0.0170	0.139	0.199	17.8
2	0.165	0.165	0.0159	0.137	0.193	17.0
3	0.162	0.160	0.0140	0.138	0.187	15.2
4	0.180	0.182	0.0203	0.144	0.216	19.9
5	0.174	0.174	0.0220	0.135	0.213	22.3
6	0.175	0.179	0.0239	0.123	0.218	27.9

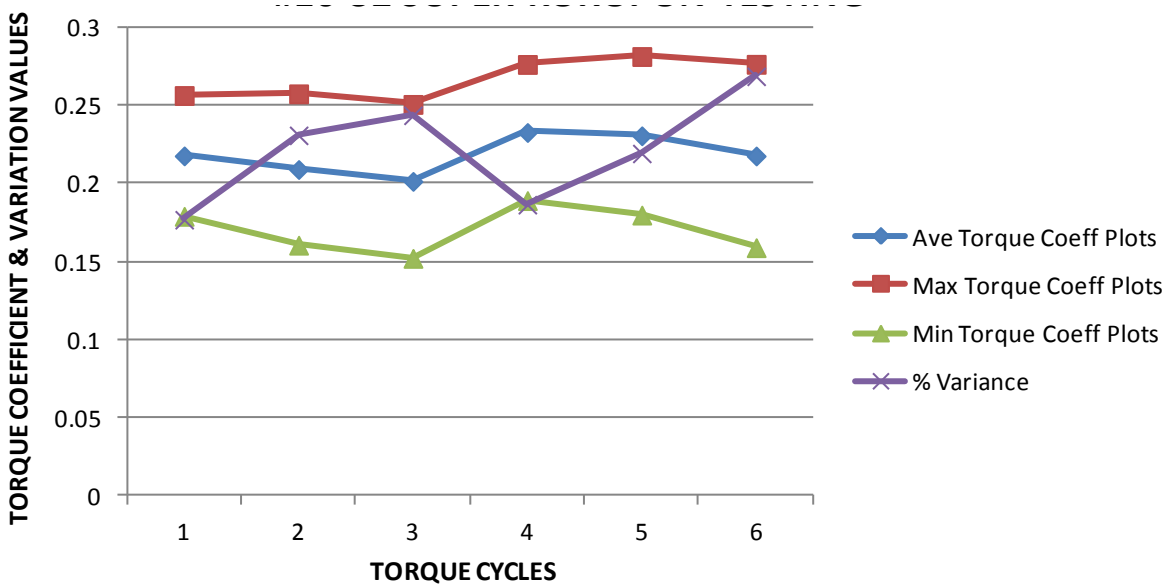


Figure 6.2.3. Torque coefficients and percent variance vs. cycles for #10-32 Super Koropon® testing.

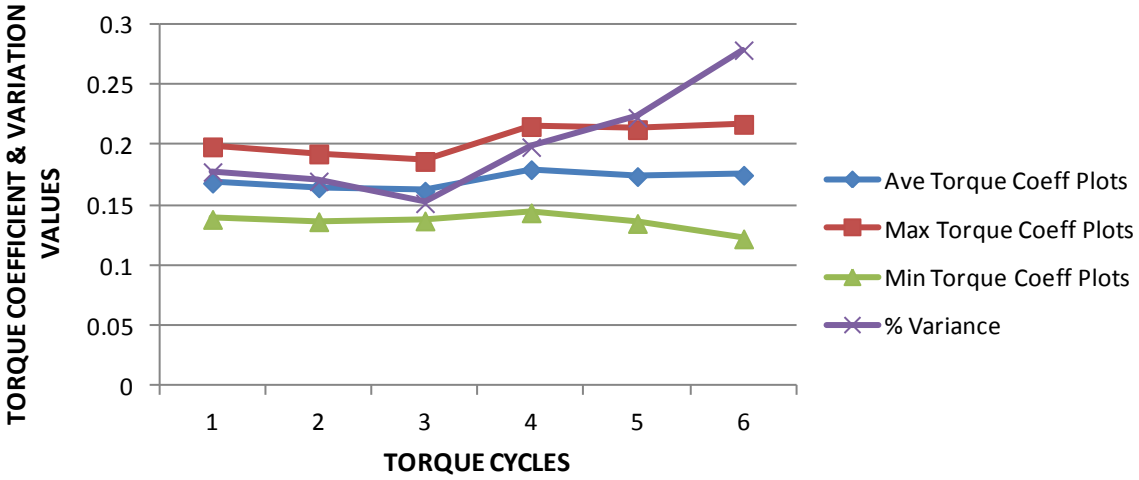


Figure 6.2.4. Torque coefficients and percent variance vs. cycles for 1/4-28 Super Koropon® testing.

Conclusions and significant observations based on the B-basis torque coefficient data plots, for both #10-32 and 1/4-28 fasteners and inserts are as follows:

- Both cleaned and un-cleaned, LD inserts in Figure 6.2.1, when lubricated with Super Koropon®, exhibited slightly lower friction coefficients than the thicker HD inserts.
- Friction coefficients decreased slightly with torque application cycles 1–3, then increased for fourth cycle on fastener and washer replacement. This can be verified on data plots in Figures 6.2.1 through 6.2.4.

The friction coefficient variance was least for cycles 1–3 and increased for cycles 4–6 on a given insert. It is noted that fasteners and washers were replaced and lubrication re-applied for the fourth cycles.

6.3 Running Torque

"Running Torque" as measured and defined in this report is that torque required to overcome friction in the threads prior to the application of fastener tensile loading. For "locking" type inserts, the running torque becomes an important factor since it is used to validate the locking feature during flight hardware integration.

The running torque was measured for all test cycles. Atypical running torque plot is shown in Figure 6.3.1. A complete set of running torque plots for #10-32 and 1/4-28 size fasteners and inserts is included in the Appendices A and B.

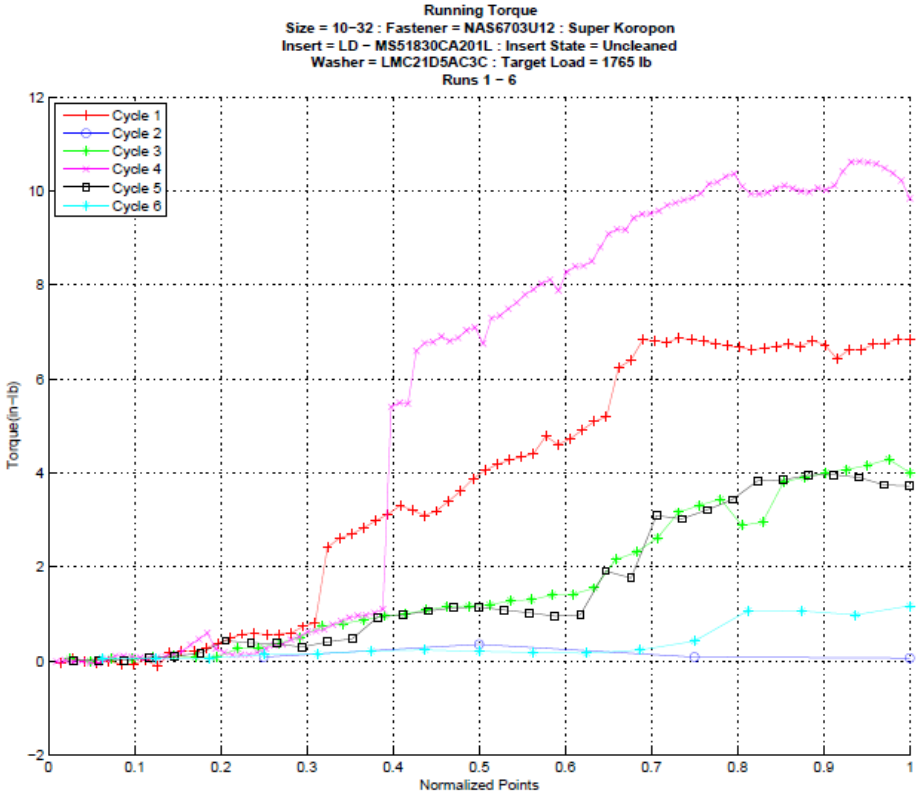


Figure 6.3.1. Running torque plot.

Based on Figure 6.3.1, the following general observations are made:

- Running torque values are highest for initial fastener torque cycles. This is confirmed by first and fourth torque cycles. Fasteners and washers are replaced after third cycle; therefore, fourth cycle is with new hardware but into the same insert.
- Running torque is reduced significantly for repeat installation cycles 2–3 and 5–6.

The above observations can also be deduced from torque tension plots (see Appendices A and B).

7.0 Test Description for 10 cycles per Keensert®

Additional testing was performed for the Orion project to determine the effect of ten cycle testing on a given Keensert®. The previous testing consisted of six cycles per insert with fastener and washer replacement after three cycles. For ten-cycle testing, fasteners and washers were not replaced unless running torque was less than the required minimum of 3 in-lbs.

Also, the previous six-cycle testing was performed without Braycote® fastener thread lubrication since Keenserts® were received with DFL applied by the manufacturer. For ten-cycle testing it was requested by the Orion project, that fastener threads be lubricated with Braycote® to determine if additional benefit could be derived by way of lower friction coefficients due to this lubrication. Two types of Braycote® lubricant were tested, Braycote® 601 and Braycote® 602EF. The Braycote® 601 contains a rust preventer while 602EF contains molybdenum disulfide which prevents galling. Testing was performed for three test conditions as follows:

1. As received DFL inserts with no additional Braycote® fastener thread lubrication.
2. As received DFL inserts with fastener threads lubricated with Braycote® 601.
3. As received DFL inserts with fastener threads lubricated with Breycote® 602EF.

It is noted that in addition to the specified test conditions above, Super Koropon® lubrication was applied under washers and bolt heads for all testing. Also, fasteners and washers were not replaced unless running torque was less than specified minimum of 3 in-lbs, at which time lubrication was reapplied. The inserts that required fastener replacement are identified in the Run Logs of Appendix C and D.

A full set of torque-tension test data, including data plots, similar to six-cycle testing is included in Appendices C and D as noted below. The torque-tension plots are shown with and without running torque. However, the spreadsheet torque coefficients calculations were performed based on removal of running torque.

Appendix C – Full set of #10-32 Torque Tension and Running Torque Plots for ten cycles per insert, Excel® Torque Coefficient Data at 65% Pre Load, Test Plate Layouts and complete set of Run Logs.

Appendix D – Full set of 1/4 - 28 Torque Tension and Running Torque Plots for ten cycles per insert, Excel® Torque Coefficient Data at 65% Pre Load, Test Plate Layouts and complete set of Run Logs.

The 0.25-28 fastener test results were based on total of (14) inserts with each insert cycled ten times. For #10-32 fasteners, a total of (8) inserts were subjected to ten cycles each. The spreadsheet calculations were performed for the different groups as follows:

- Fastener threads lubricated with Braycote® 601 inserted into HD and EXHD Keenserts®.
- Fastener threads lubricated with Braycote® 602EF inserted into HD and EXHD Keenserts®.
- As received, un-lubricated fasteners inserted into HD and EXHD Keenserts®.

7.1 Torque tension data plots are presented in two formats as shown below:

1. Typical torque tension plot for ten insertions into a given insert, with and without running torque is shown in Figure 7.1.
2. Typical cycle plots for individual cycles where all first, second, and third cycles are combined individually is shown in Figure 7.2.

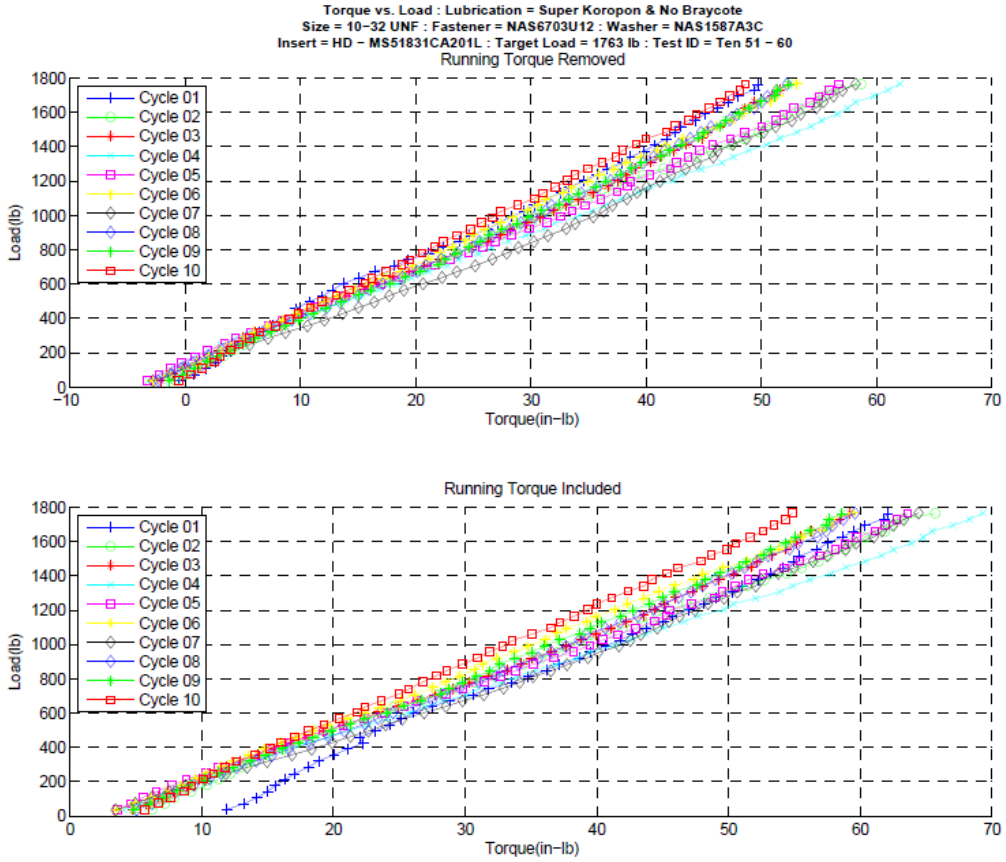


Figure 7.1. Torque-tension plots combining all ten cycles with and without running torque.

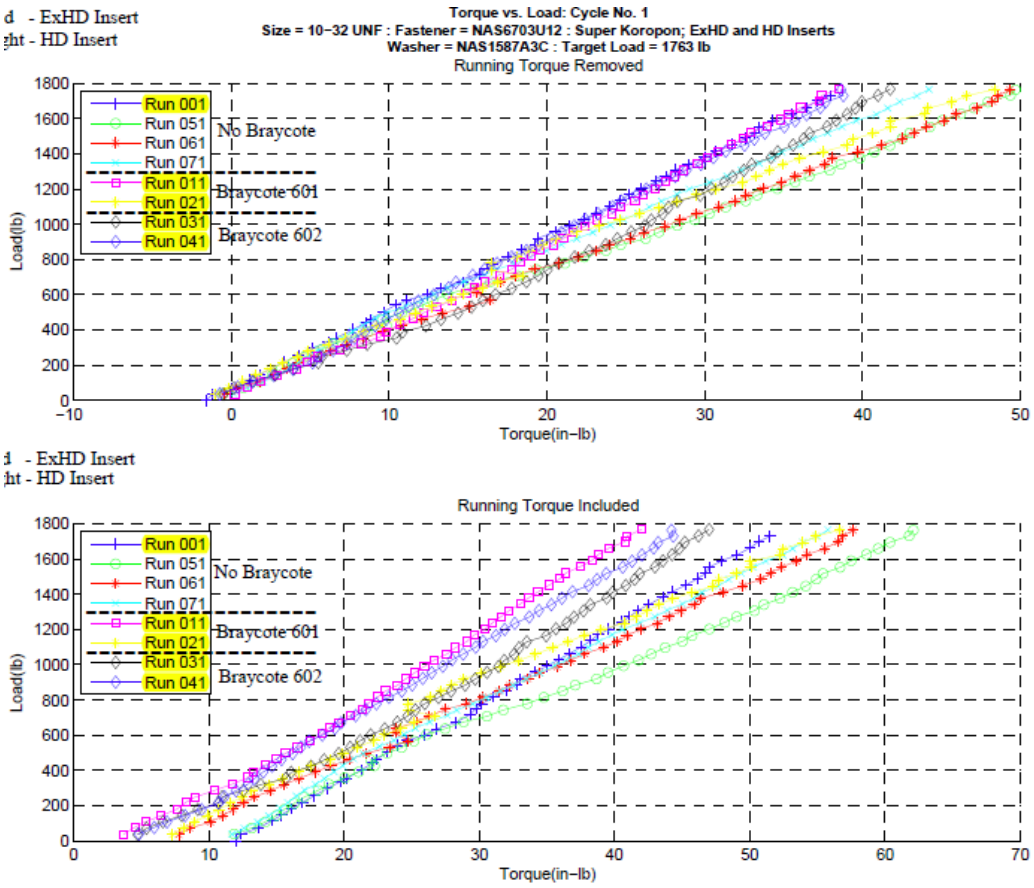


Figure 7.2. Torque-cycle plots combining all first cycles with and without running torque.

A complete set of these plots can be found in Appendix - C for # 10-32 and Appendix - D for 0.25-28 fasteners and inserts. The cycle plots can be used to evaluate the effect of various variables such as insert type, lubrication etc. on torque coefficient whereas the torque-tension plots indicate change due to torque application cycles into a given insert.

7.2 Excel® data sheet calculations at 65 percent Preload

These calculations were performed using single and two tailed B-basis methods similar to that used for six-cycle testing as described in section 5.2 of this report. The details of these calculations are included in Appendices C and D.

Figure 7.3 is a summary of measured and calculated torque coefficient variation with torque application cycles 1–10. The specific torque coefficients are defined as follows:

1. Combined mean - is the calculated Kmean based on all (8) #10-32 data points for a given cycle. The number of data points is equal to number of inserts tested.
2. Calculated Kmax 90/95 – The two-sided B-basis Kmax based on Kmean + Standard Deviation x B-basis constant for number of data points.
3. Calculated Kmin 90/95 – The two-sided B-basis Kmin based on Kmean – Standard Deviation x B-basis constant for number of data points.

4. Max Data Torque Coefficient - maximum measured torque coefficient for the (8) inserts tested in that specified torque cycle.
5. Minimum Data Torque Coefficient - minimum measured torque coefficient for the (8) inserts tested in that specified torque cycle.

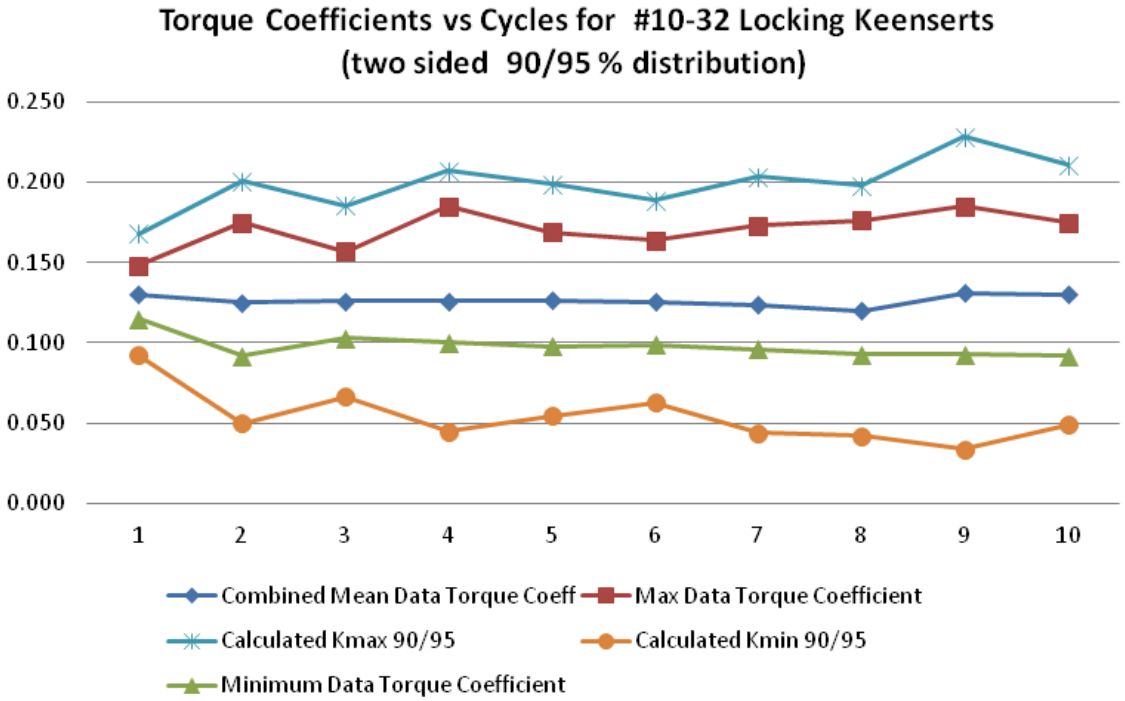


Figure 7.3. Torque coefficients vs. cycles for Kave, Kmax and Kmin measured and calculated.

Significant observations based on Figure 7.3 are as follows:

- The difference in (Kmax- Kmin) for both calculated and measured values is least for first cycle, indicating that preload uncertainty increases for follow-on torque cycles. It should be noted that fastener assembly was not re-lubricated between cycles and fastener/washers were not replaced.
- The calculated Kmean does not change significantly for first six cycles. However, as noted above the variation or increase in (Kmax-Kmin) for follow-on torque cycles is significant.
- Based on measured torque coefficients, Kmax from Kmean is greater than that for Kmin for follow on cycles.
- The calculated B-basis Kmax and Kmin values are conservative since all measured data values fall within these calculated values. This is further substantiated by Figure 7.4.

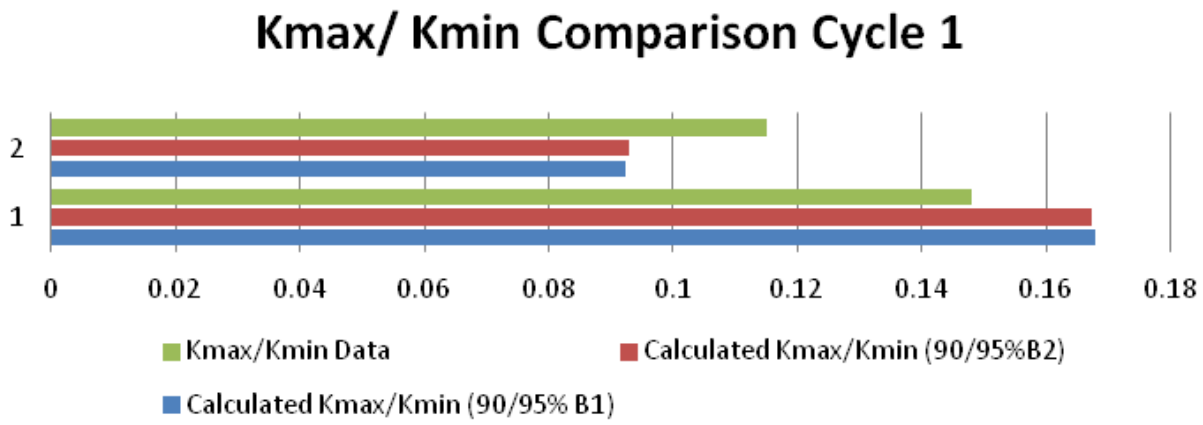


Figure 7.4. Comparison of Kmax and Kmin measured and calculated for typical first torque cycle.

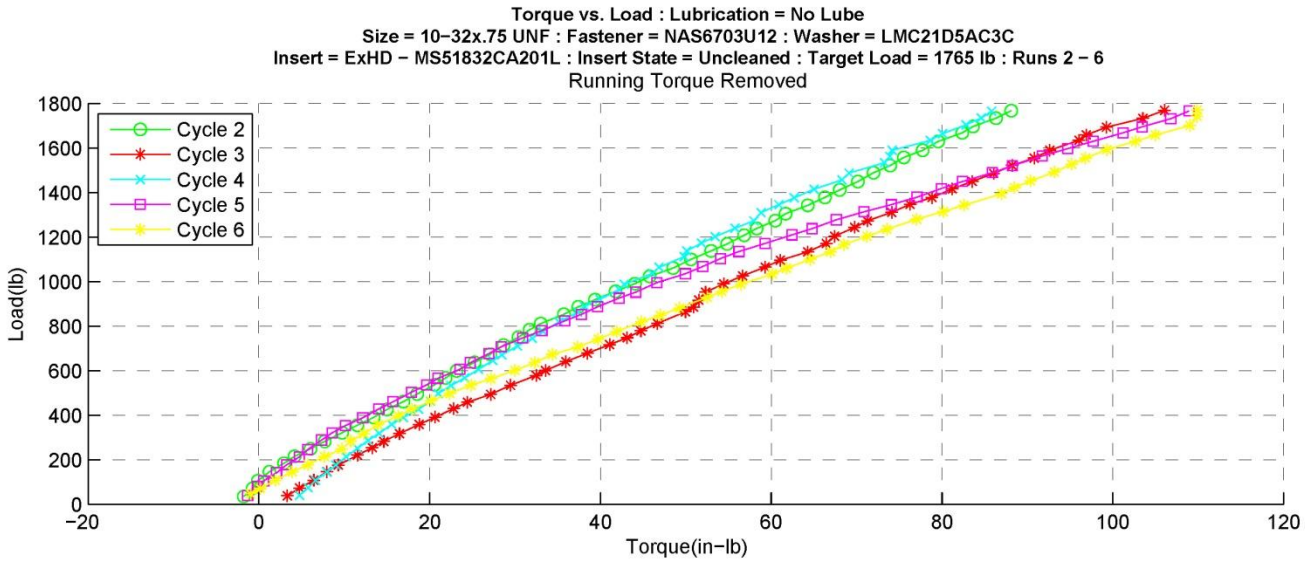
Significant observations based on Figure 7.4 are as follow:

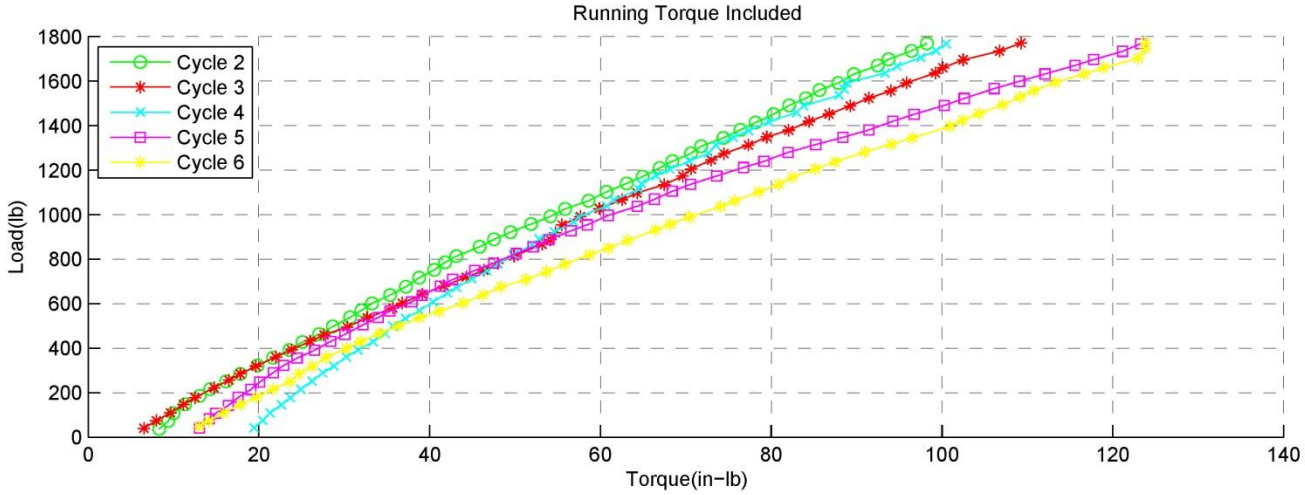
1. The calculated B-basis values for both Kmin and Kmax are nearly equal for single- and two-tailed basis.
2. For a given applied torque, the calculated Kmin values are lower than the measured values which is conservative with respect to predicted maximum preload. The lower Kmin will predict a higher preload than that based on minimum measured value.
3. Conversely, the calculated Kmax values are greater than the measured values, which is again conservative since it will predict a lower preload than that based on measured values.

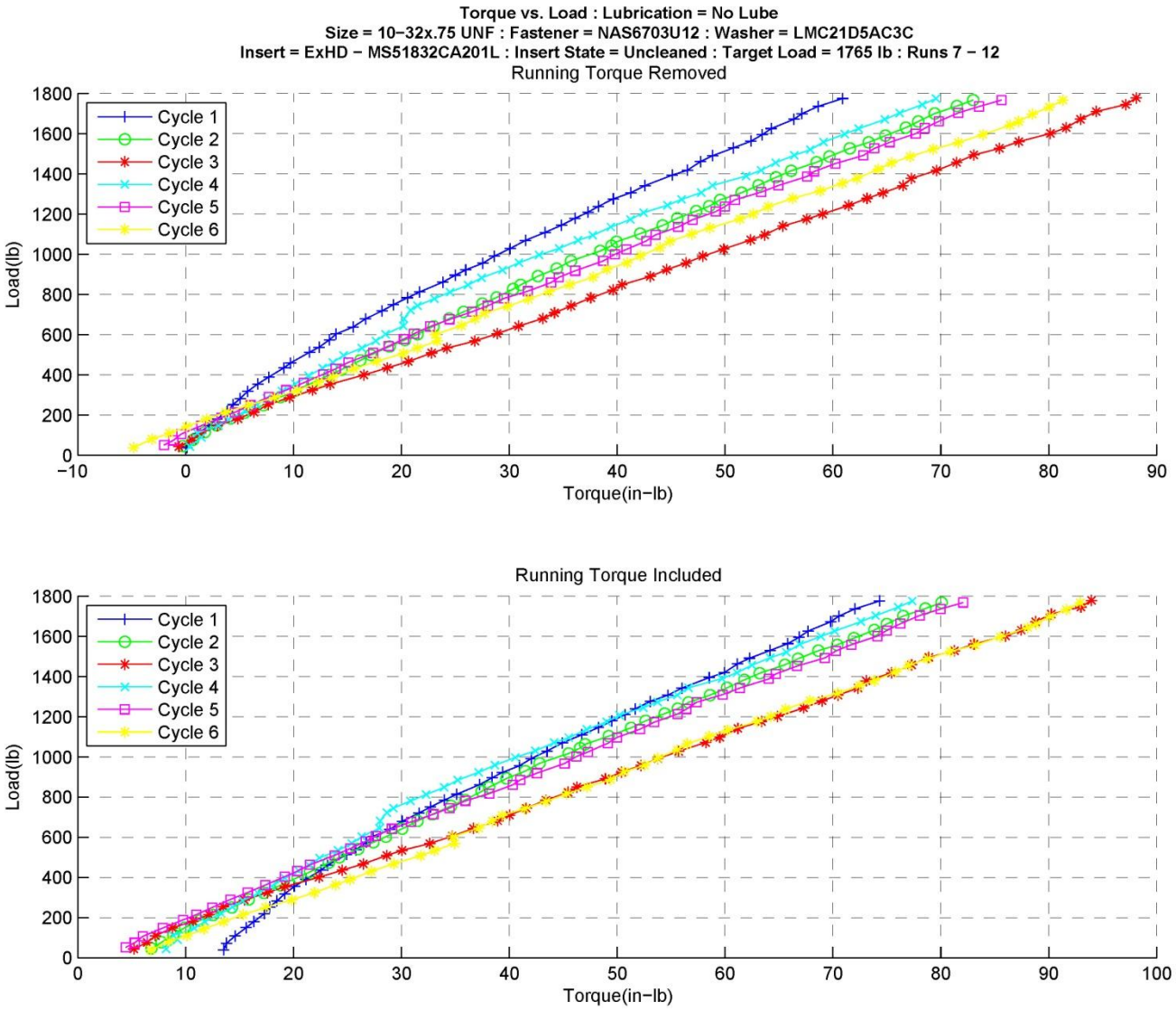
Appendix A – Full set of #10-32 Torque Tension and Running Torque Plots, Excel® Torque Coefficient Data at 65 percent Pre Load, Test Plate Layouts and complete set of Run Logs.

Appendix A:

Section 1	10-32 Dry Torque Tension Plots
Section 2	10-32 Wet Torque Tension Plots
Section 3	10-32 Dry Running Torque Plots
Section 4	10-32 Wet Running Torque Plots
Section 5	10-32 Dry Cycle Plots: Torque vs. Load
Section 6	10-32 Wet Cycle Plots: Torque vs. Load
Section 7	10-32 Friction Coefficients
Section 8	10-32 Test Plate Layouts
Section 9	10-32 Dry Run Logs
Section 10	10-32 Wet Run Logs


Torque vs. Load : Lubrication = No Lube
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = ExHD − MS51832CA201L : Insert State = Uncleaned : Target Load = 1765 lb : Runs 2 − 6
Running Torque Removed
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)


Running Torque Included
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)


Torque vs. Load : Lubrication = No Lube
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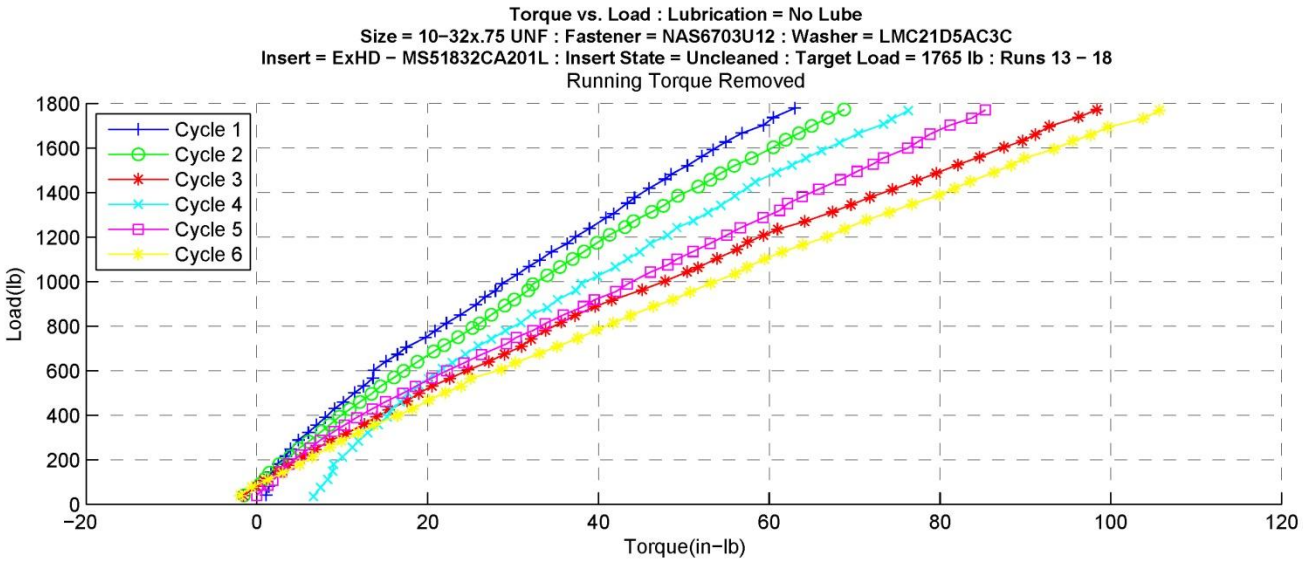
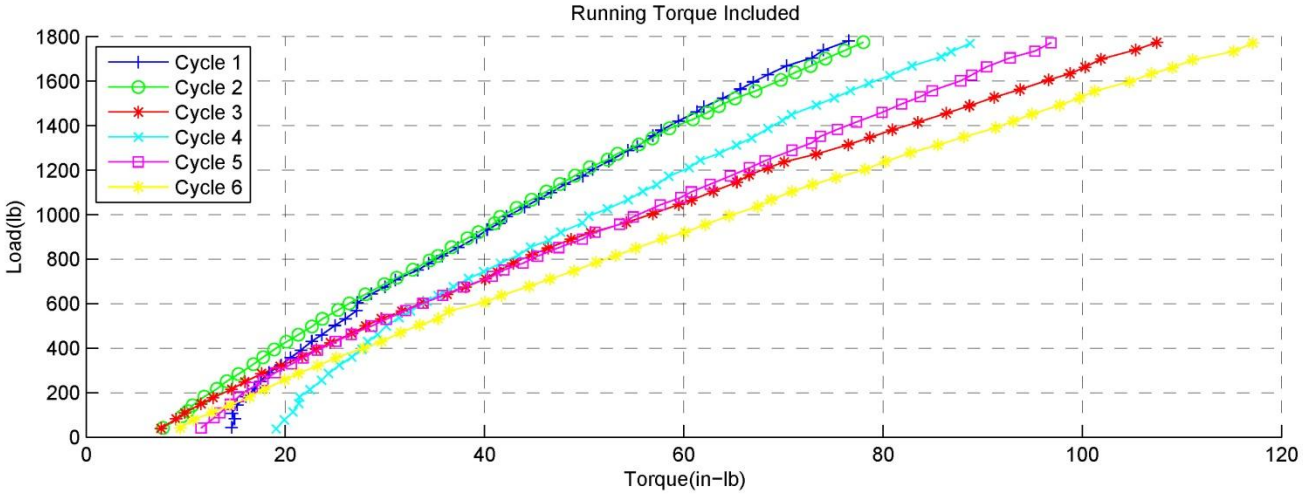
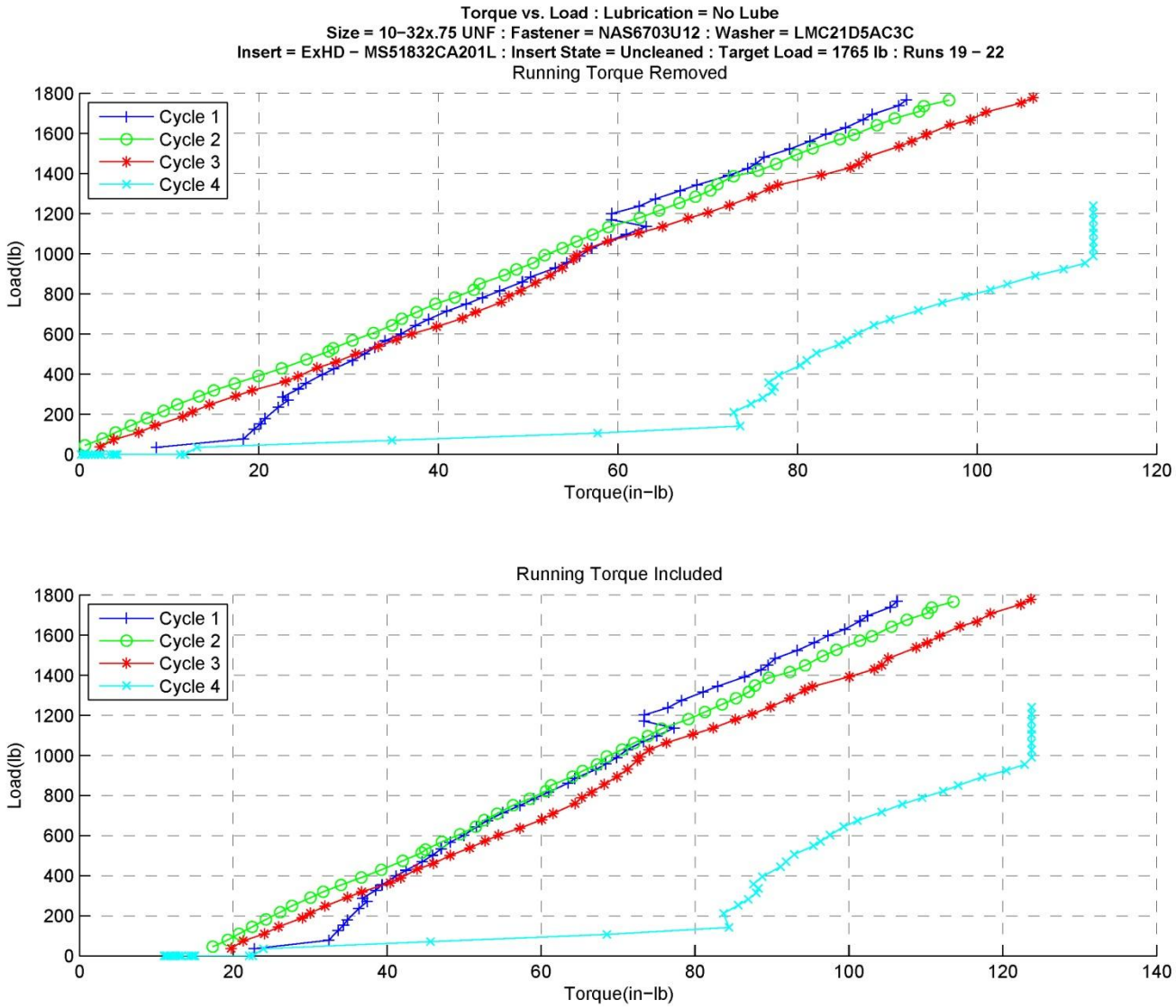
Insert = ExHD − MS51832CA201L : Insert State = Uncleaned : Target Load = 1765 lb : Runs 7 − 12
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)


Torque vs. Load : Lubrication = No Lube
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = ExHD − MS51832CA201L : Insert State = Uncleaned : Target Load = 1765 lb : Runs 13 − 18
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
0
200
400
600
800
1000
1200
1400
1600
1800
−20
0
20
40
60
80
100
120


Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
20
40
60
80
100
120


Torque vs. Load : Lubrication = No Lube
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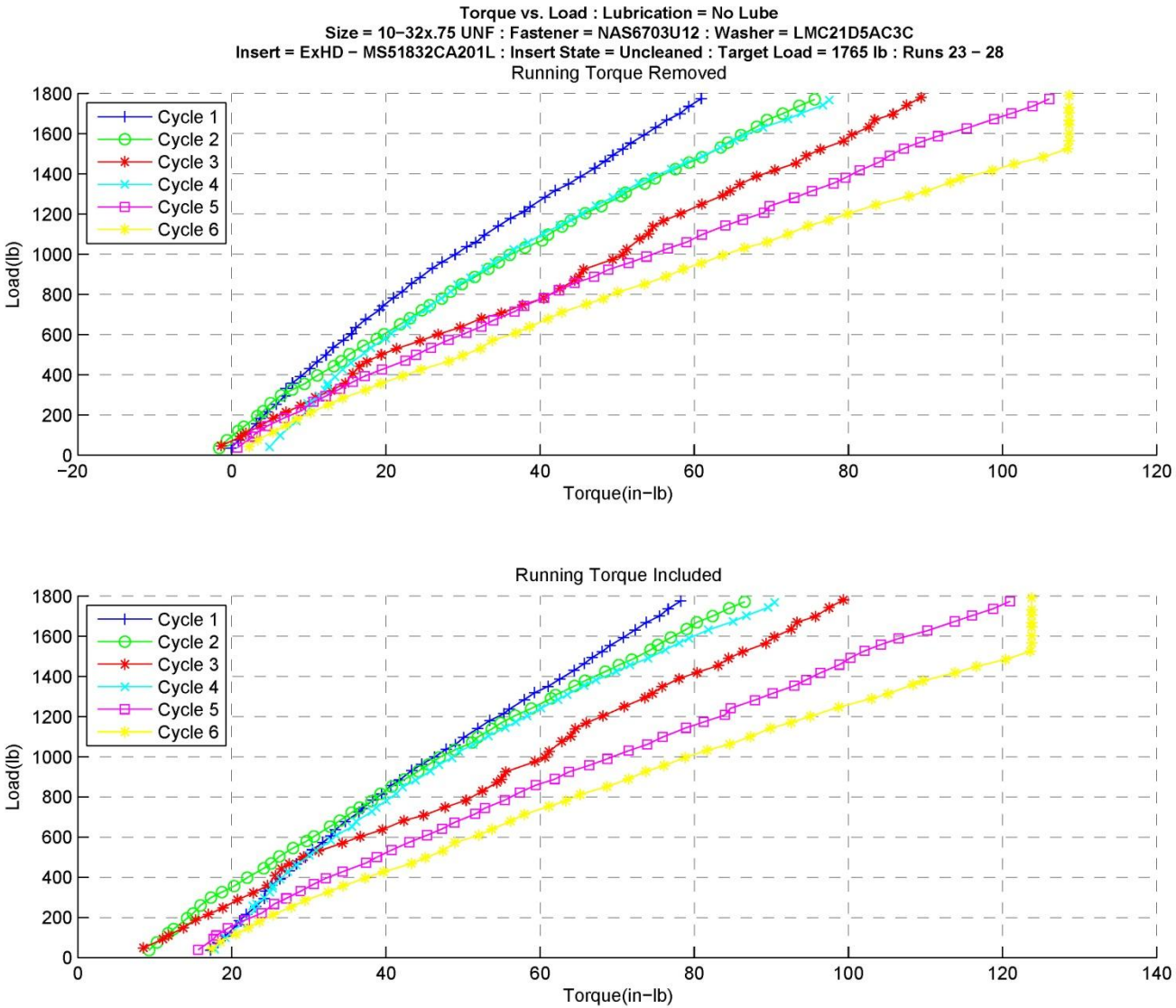
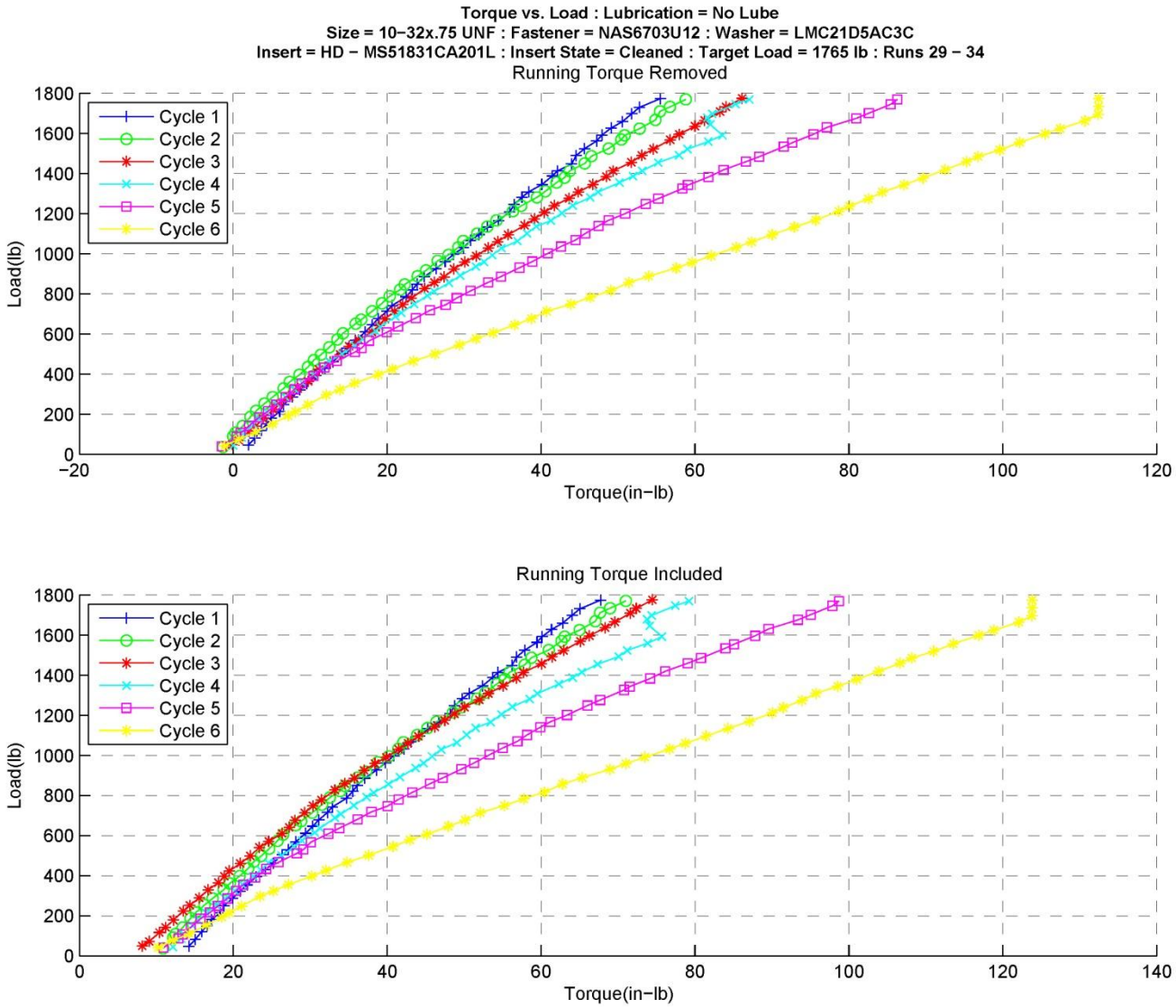
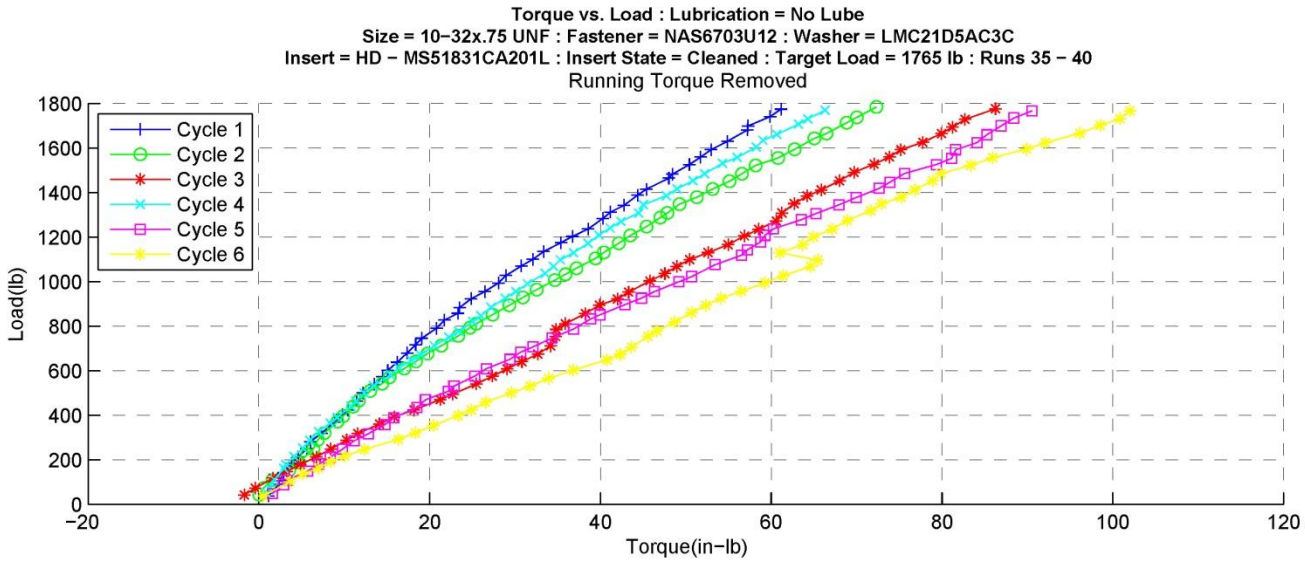
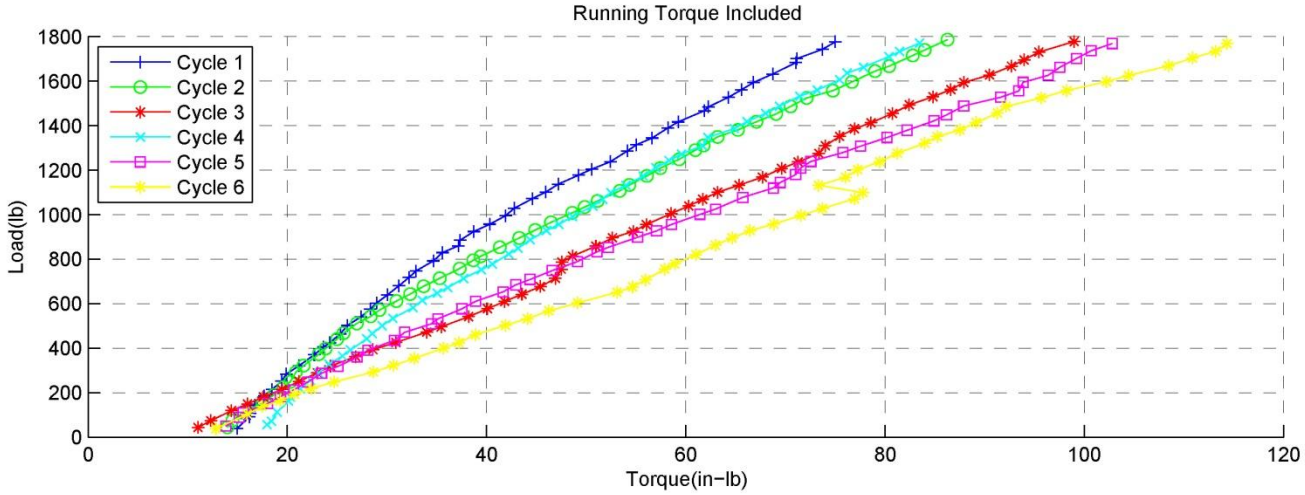
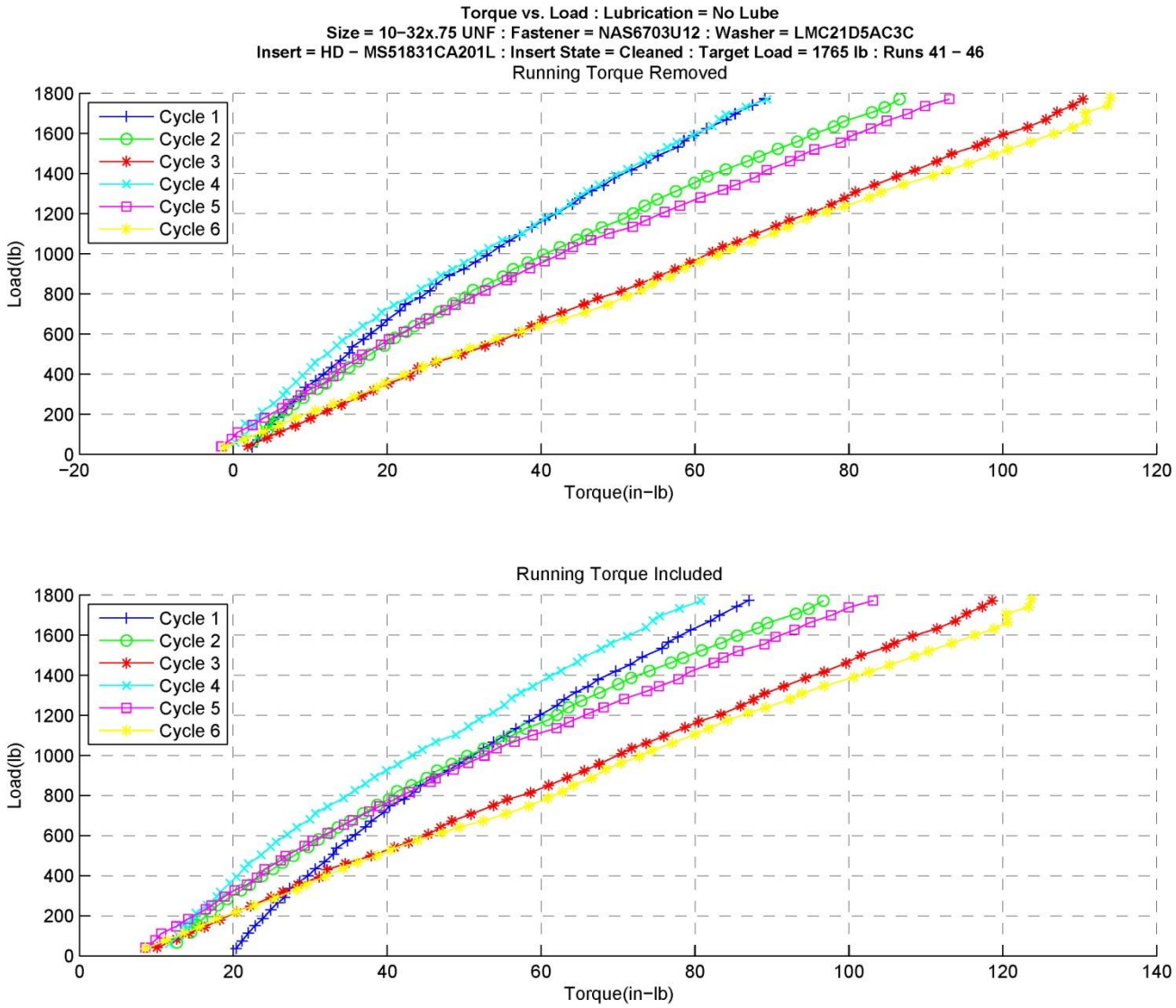
Insert = ExHD − MS51832CA201L : Insert State = Uncleaned : Target Load = 1765 lb : Runs 19 − 22
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Load(lb)
Torque(in−lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
20
40
60
80
100
120
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Load(lb)
Torque(in−lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
20
40
60
80
100
120
140

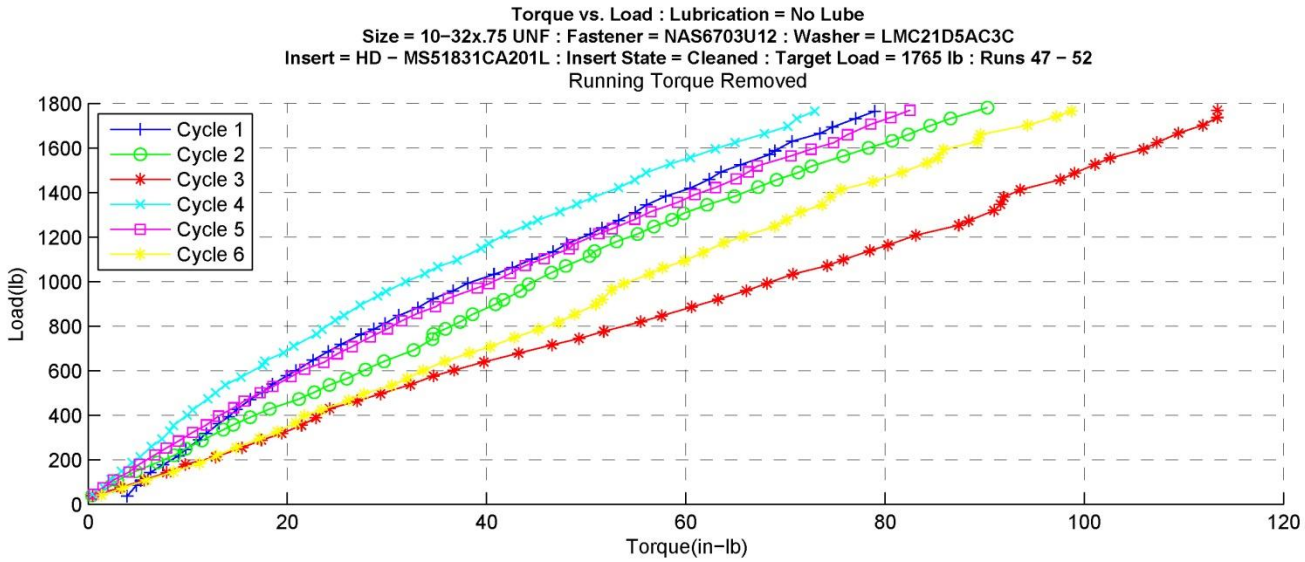

Torque vs. Load : Lubrication = No Lube
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = ExHD − MS51832CA201L : Insert State = Uncleaned : Target Load = 1765 lb : Runs 23 − 28
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

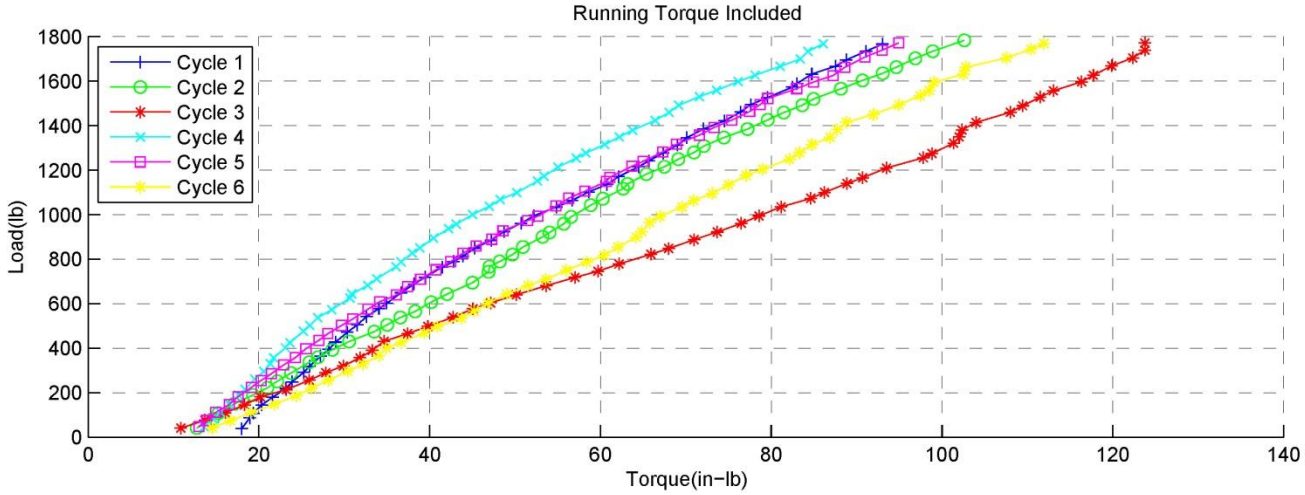

Torque vs. Load : Lubrication = No Lube
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = HD − MS51831CA201L : Insert State = Cleaned : Target Load = 1765 lb : Runs 29 − 34
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

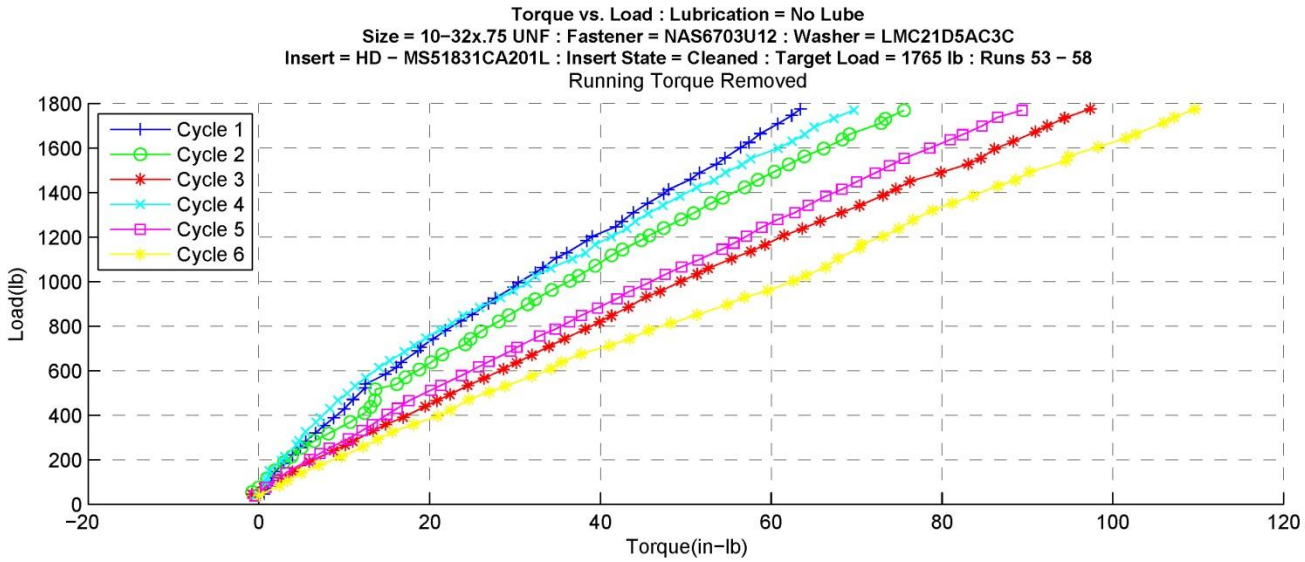

Torque vs. Load : Lubrication = No Lube
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = HD − MS51831CA201L : Insert State = Cleaned : Target Load = 1765 lb : Runs 35 − 40
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

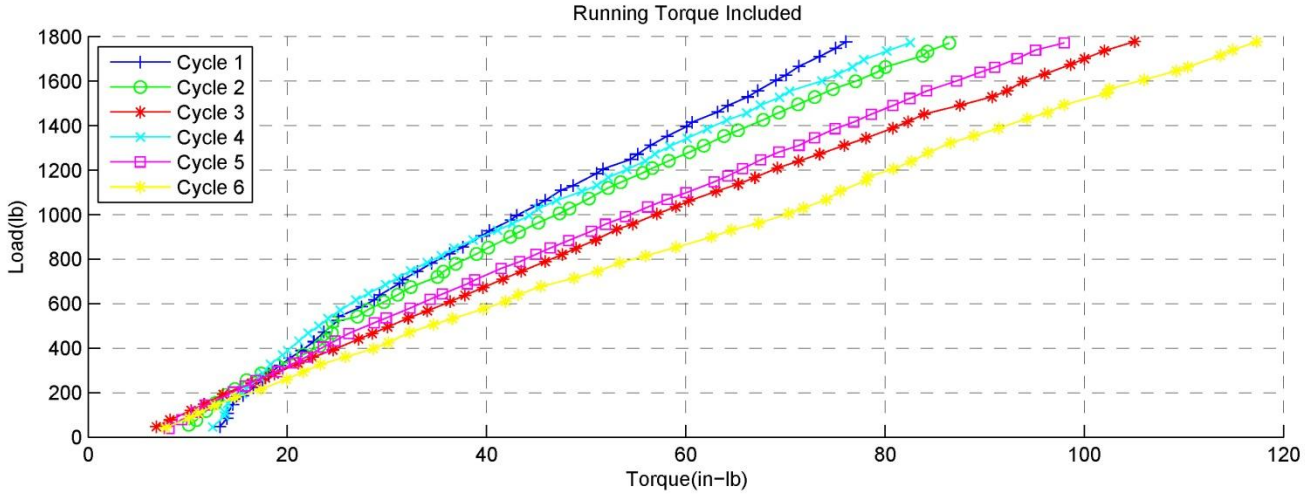

Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

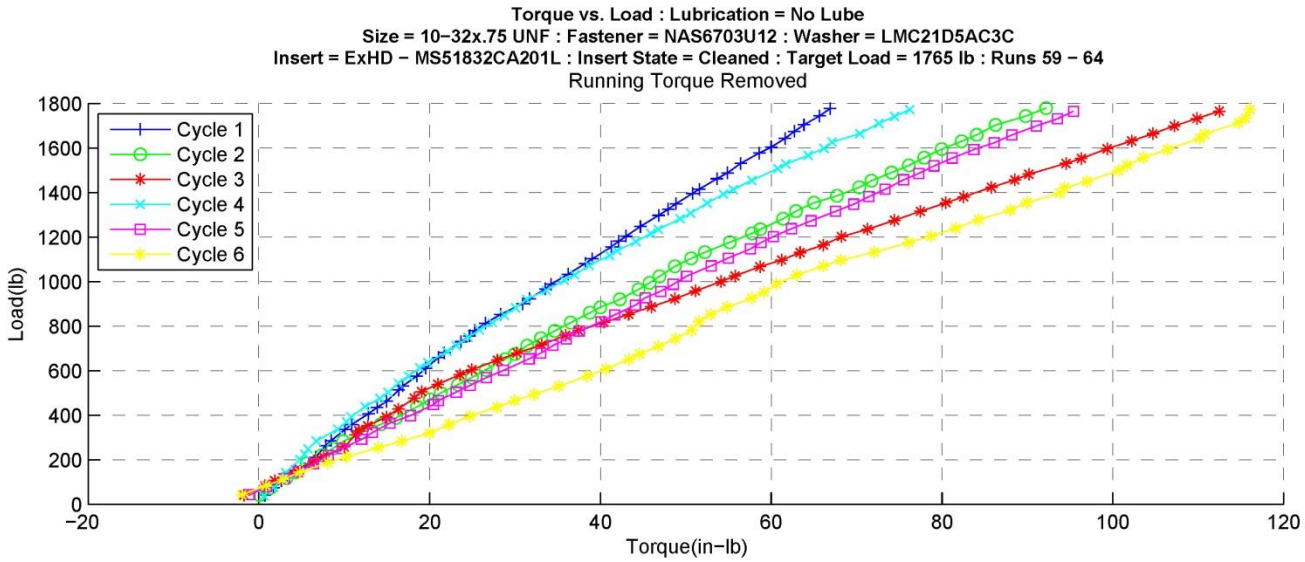

Torque vs. Load : Lubrication = No Lube
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = HD − MS51831CA201L : Insert State = Cleaned : Target Load = 1765 lb : Runs 41 − 46
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

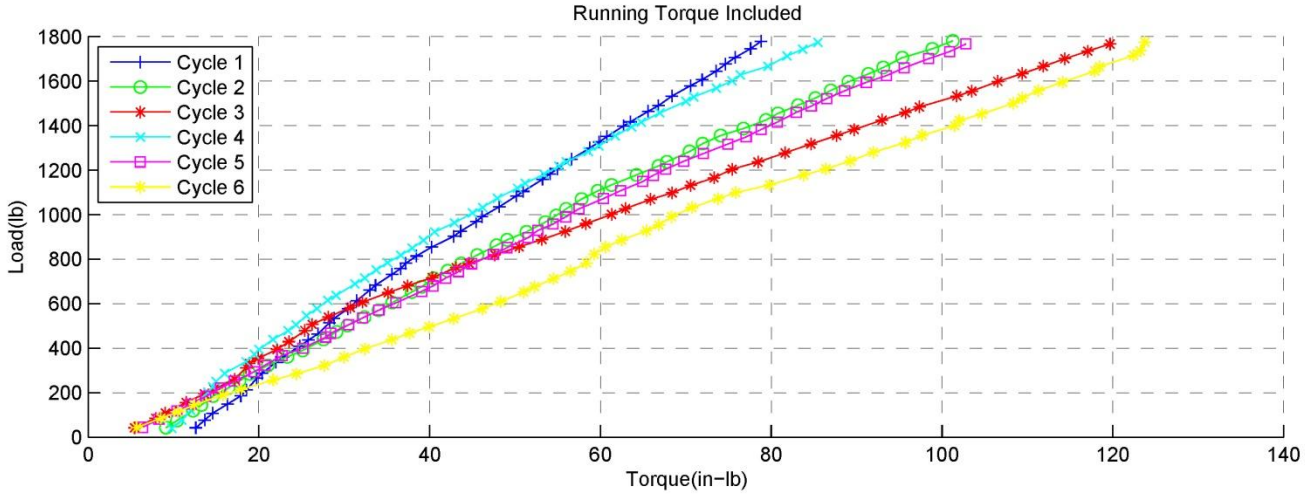

Torque vs. Load : Lubrication = No Lube
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = HD − MS51831CA201L : Insert State = Cleaned : Target Load = 1765 lb : Runs 47 − 52
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
20
40
60
80
100
120

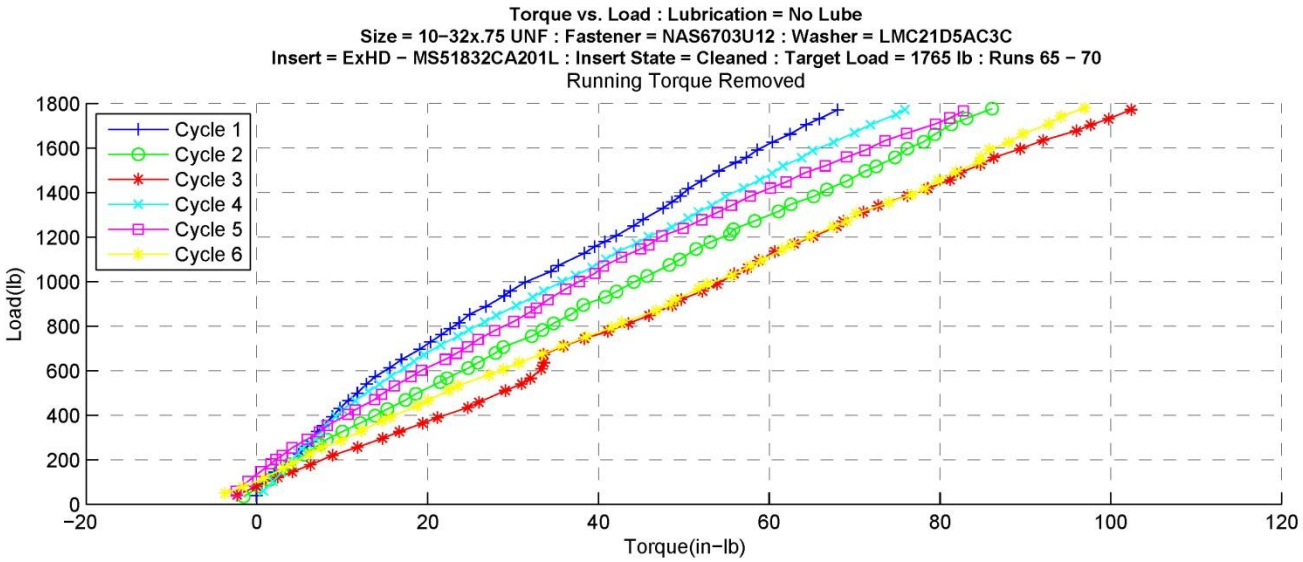

Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
20
40
60
80
100
120
140

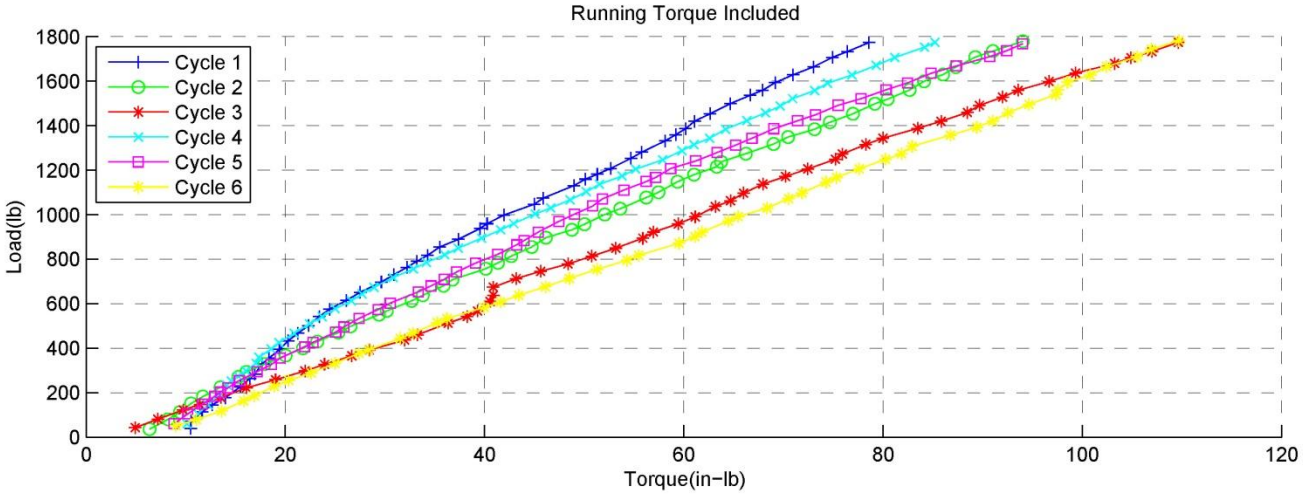

Torque vs. Load : Lubrication = No Lube
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = HD − MS51831CA201L : Insert State = Cleaned : Target Load = 1765 lb : Runs 53 − 58
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

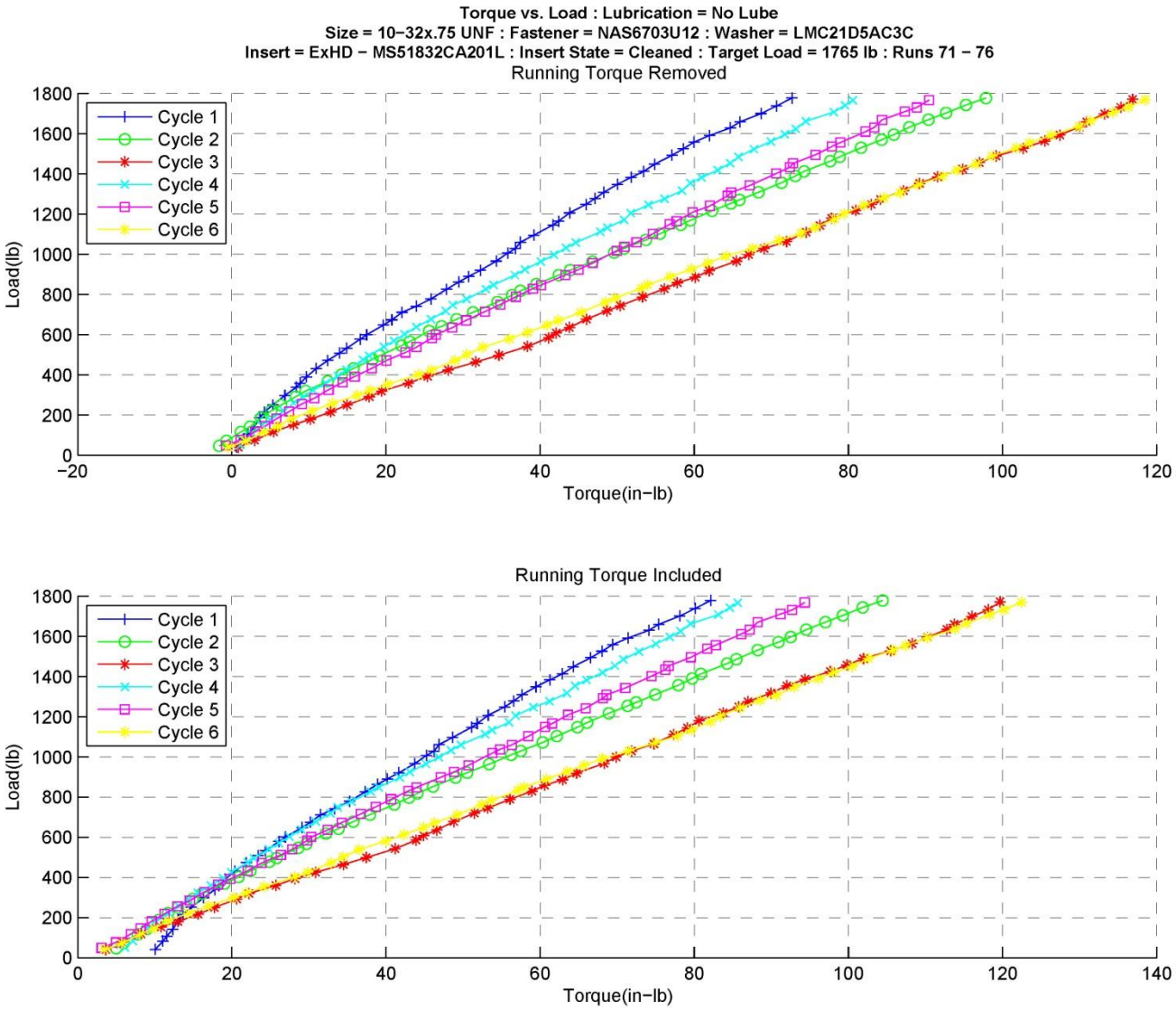

Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

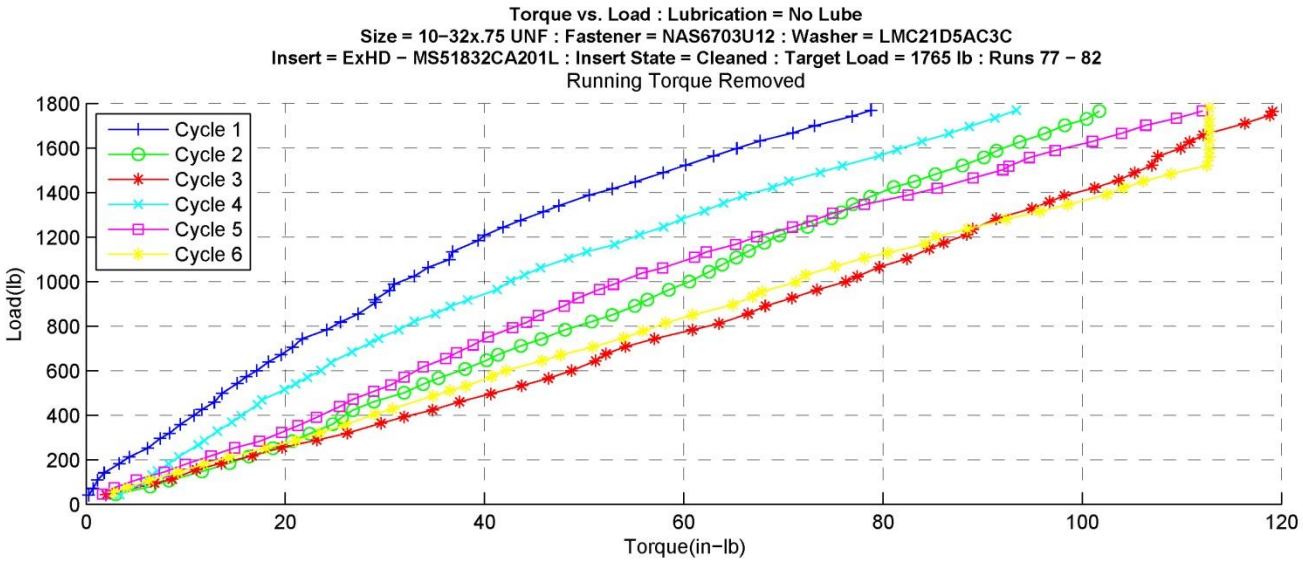

Torque vs. Load : Lubrication = No Lube
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = ExHD − MS51832CA201L : Insert State = Cleaned : Target Load = 1765 lb : Runs 59 − 64
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
0
200
400
600
800
1000
1200
1400
1600
1800
−20
0
20
40
60
80
100
120

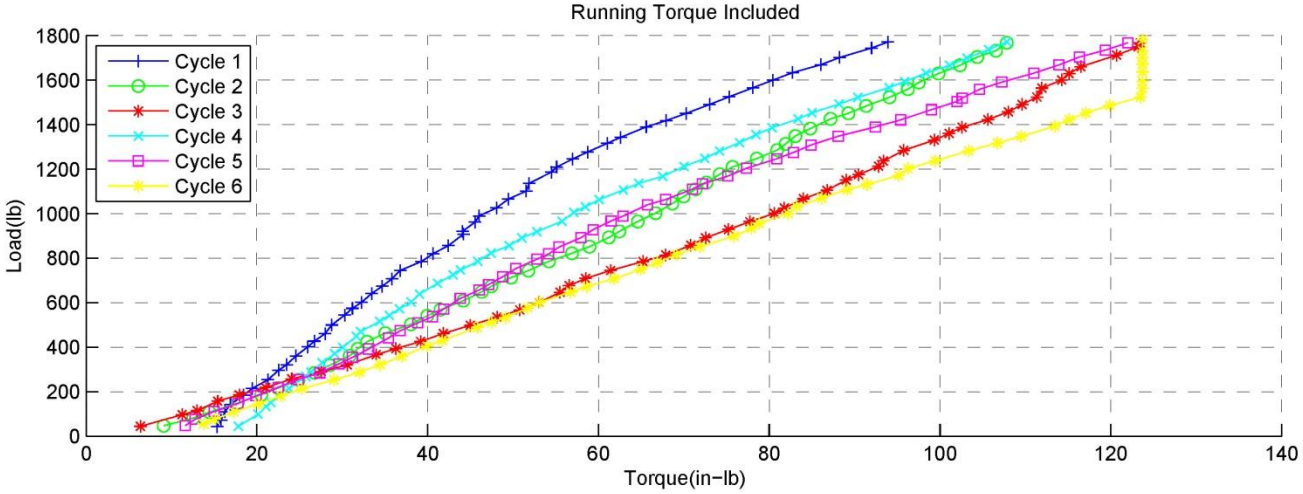

Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
20
40
60
80
100
120
140


Torque vs. Load : Lubrication = No Lube
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = ExHD − MS51832CA201L : Insert State = Cleaned : Target Load = 1765 lb : Runs 65 − 70
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)


Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

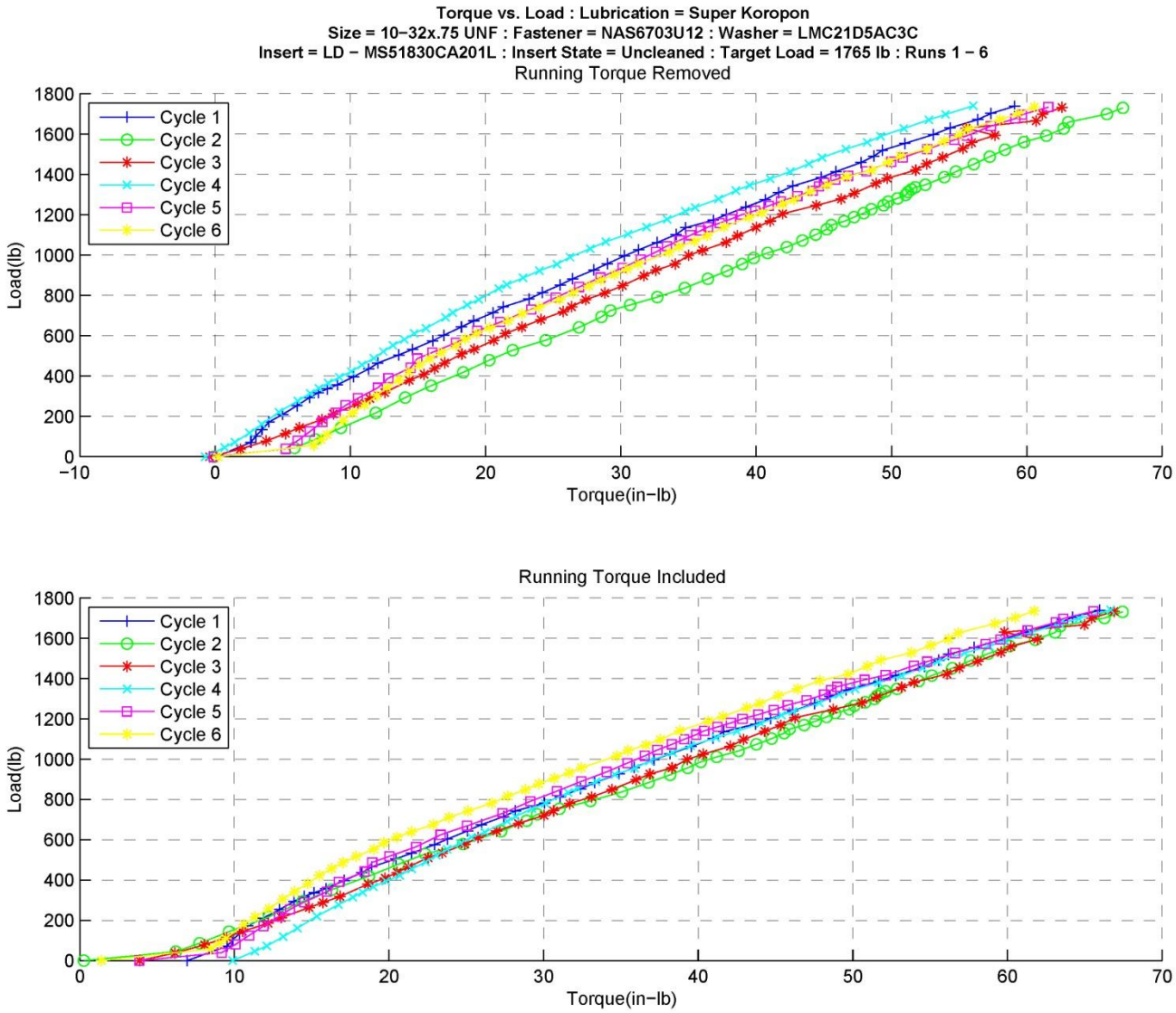

Torque vs. Load : Lubrication = No Lube
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = ExHD − MS51832CA201L : Insert State = Cleaned : Target Load = 1765 lb : Runs 71 − 76
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

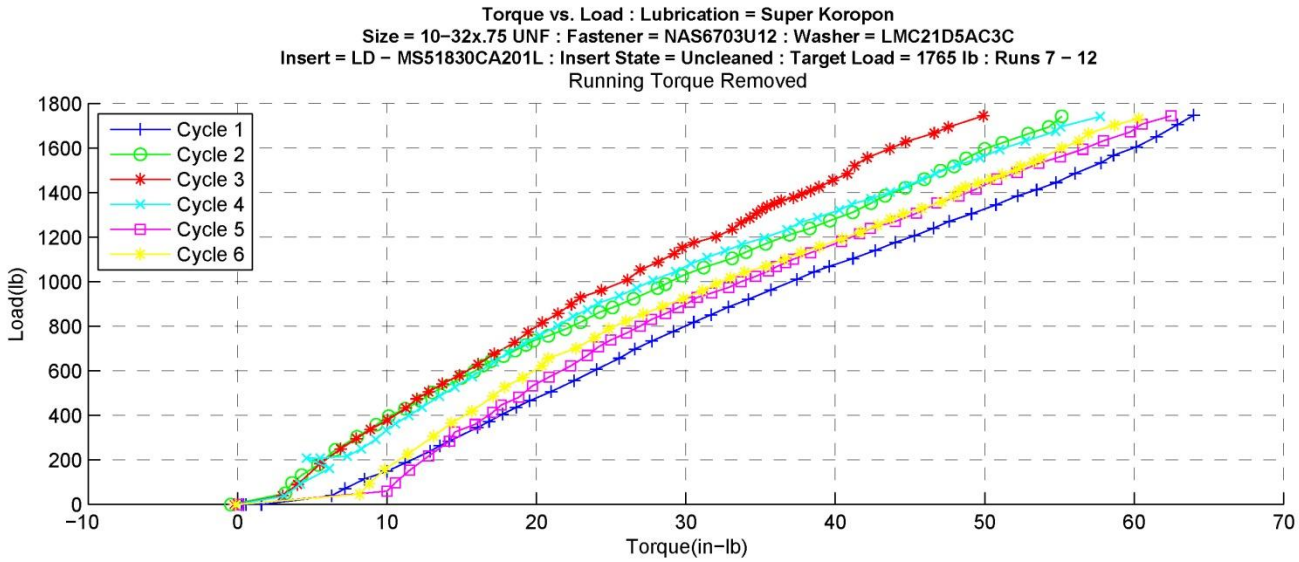

Torque vs. Load : Lubrication = No Lube
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = ExHD − MS51832CA201L : Insert State = Cleaned : Target Load = 1765 lb : Runs 77 − 82
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
20
40
60
80
100
120

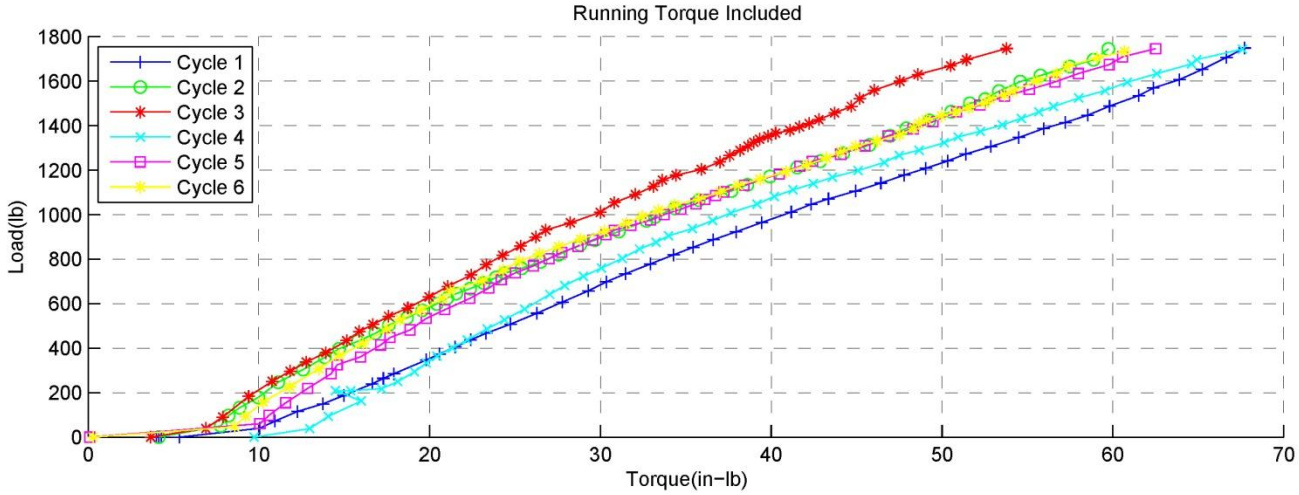

Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
20
40
60
80
100
120
140

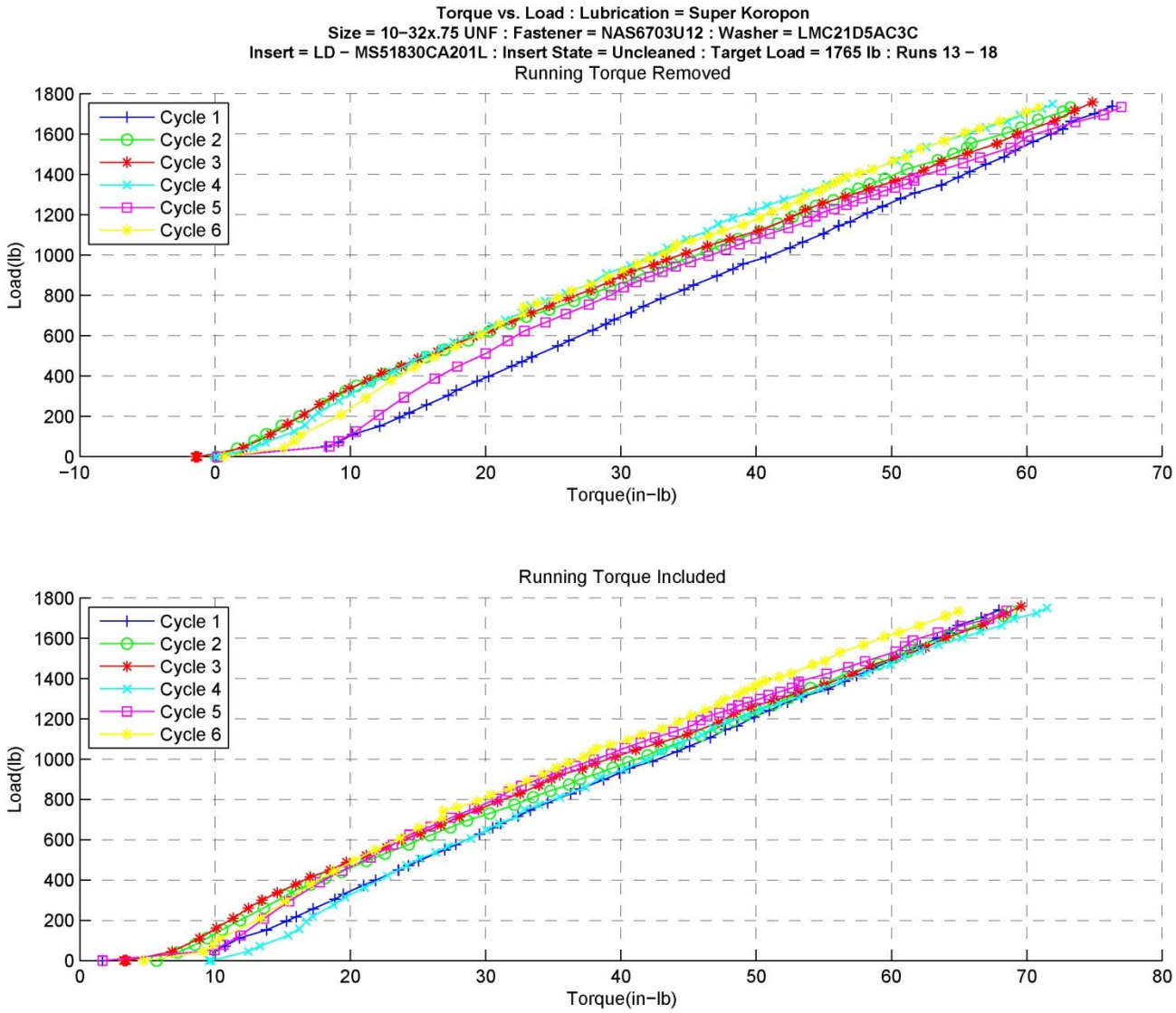
Appendix A:

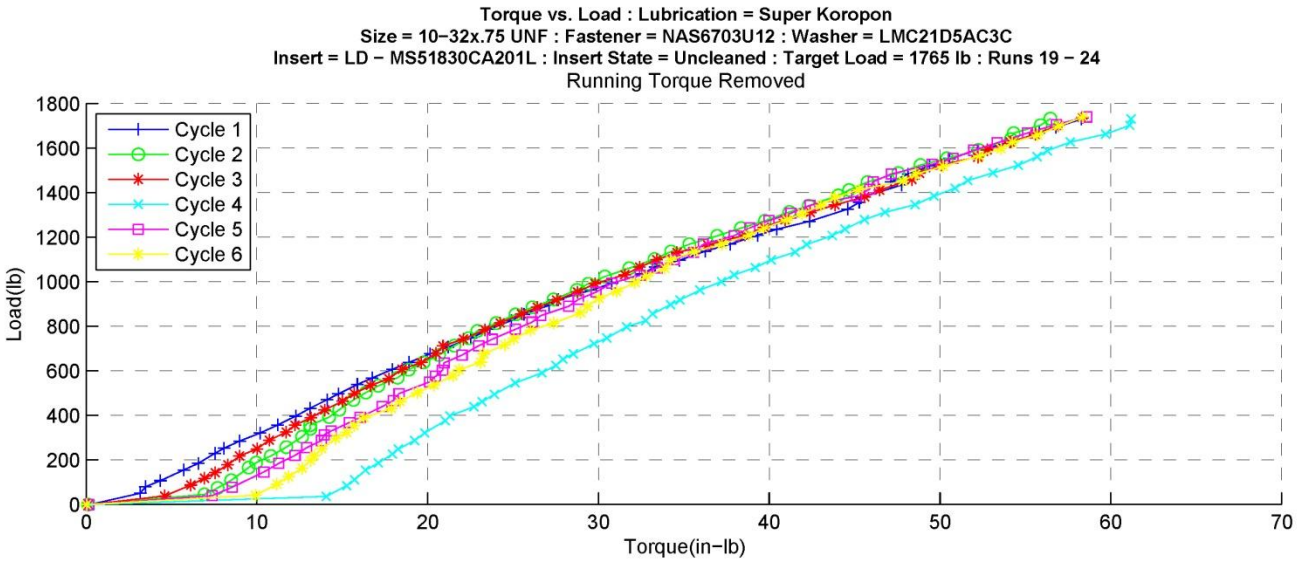
Section 1	10-32 Dry Torque Tension Plots
Section 2	10-32 Wet Torque Tension Plots
Section 3	10-32 Dry Running Torque Plots
Section 4	10-32 Wet Running Torque Plots
Section 5	10-32 Dry Cycle Plots: Torque vs. Load
Section 6	10-32 Wet Cycle Plots: Torque vs. Load
Section 7	10-32 Friction Coefficients
Section 8	10-32 Test Plate Layouts
Section 9	10-32 Dry Run Logs
Section 10	10-32 Wet Run Logs

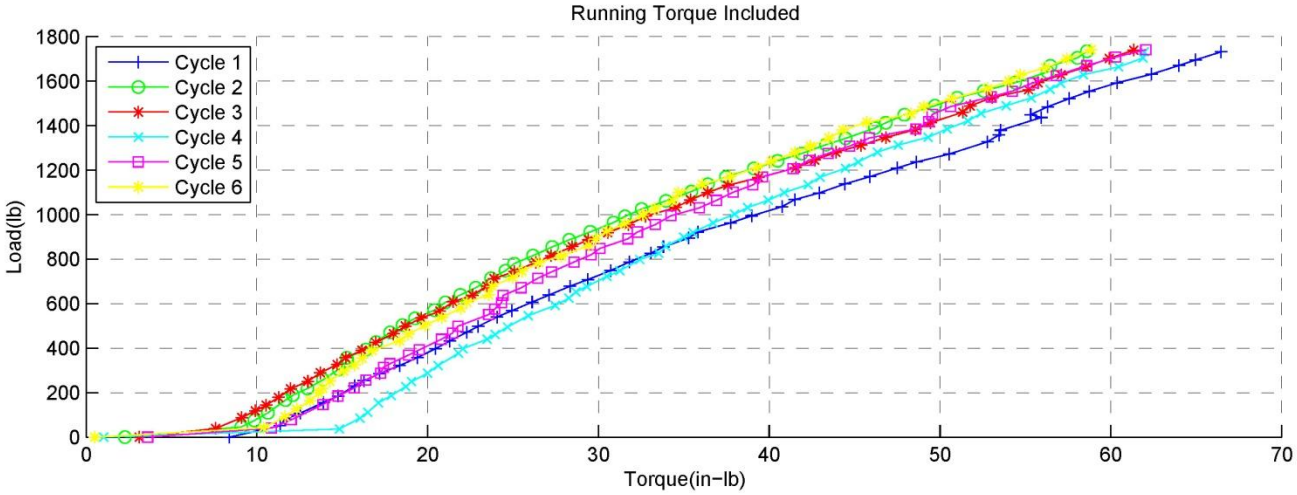

Torque vs. Load : Lubrication = Super Koropon
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = LD − MS51830CA201L : Insert State = Uncleaned : Target Load = 1765 lb : Runs 1 − 6
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

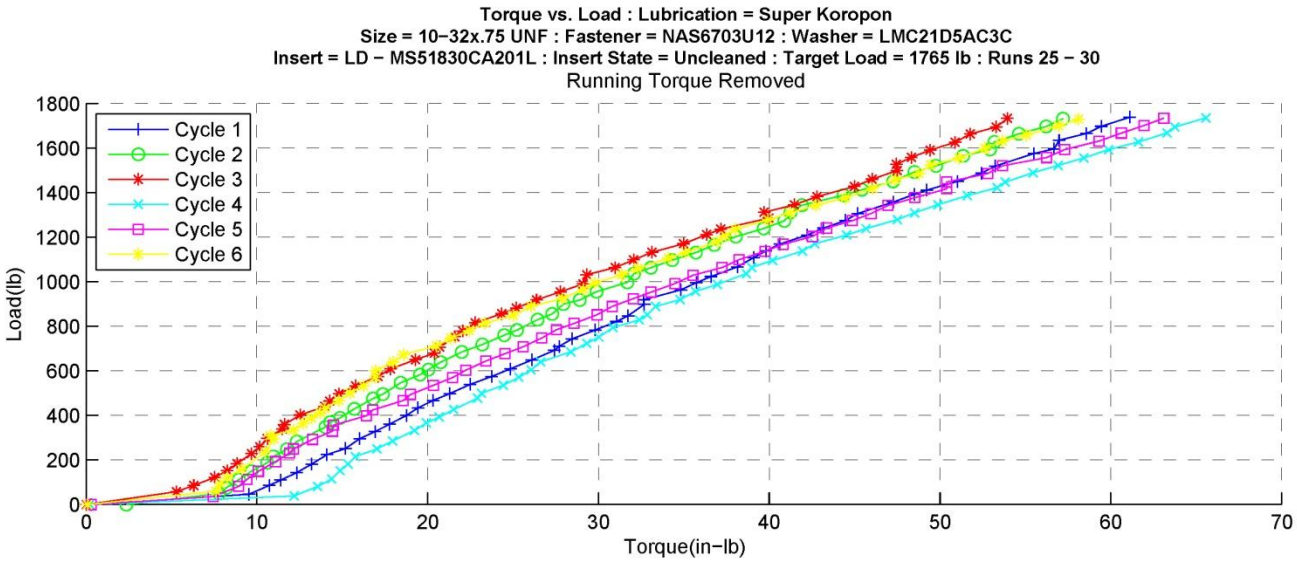

Torque vs. Load : Lubrication = Super Koropon
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = LD − MS51830CA201L : Insert State = Uncleaned : Target Load = 1765 lb : Runs 7 − 12
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

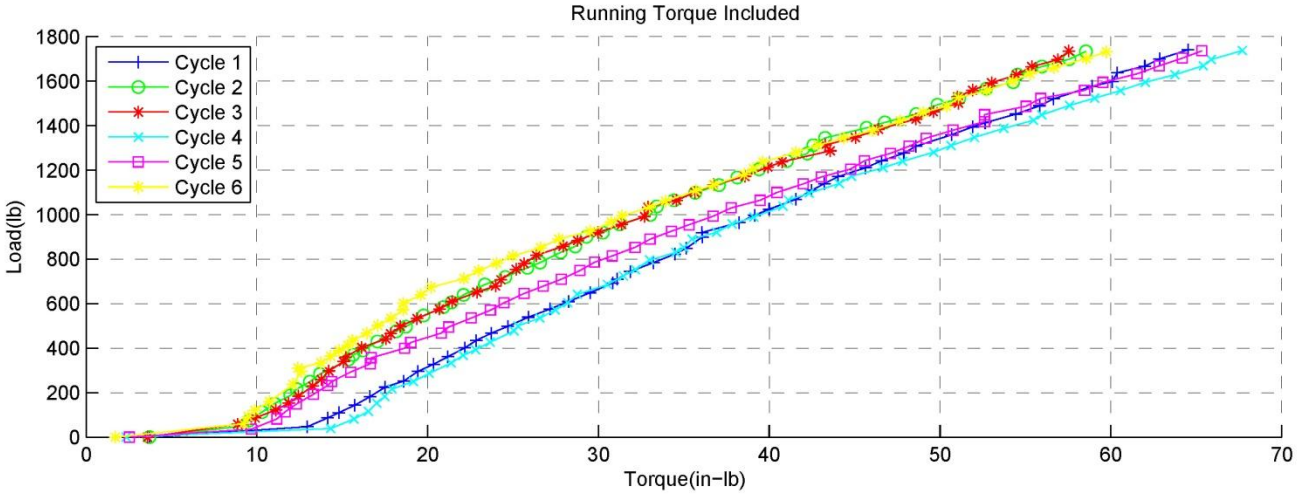

Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

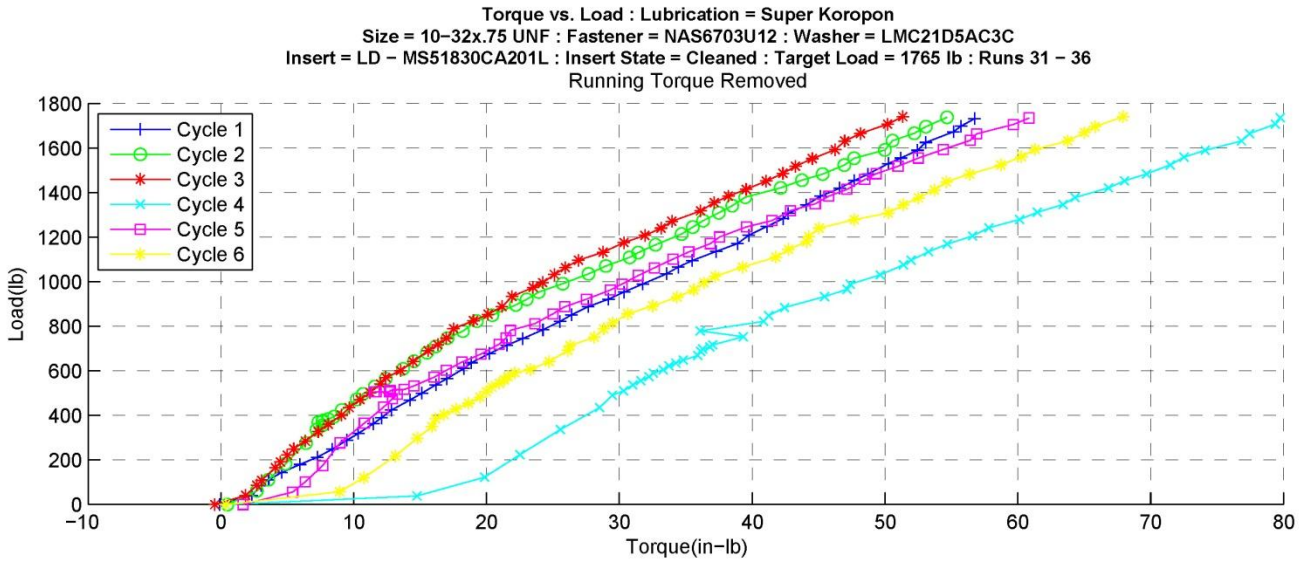

Torque vs. Load : Lubrication = Super Koropon
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = LD − MS51830CA201L : Insert State = Uncleaned : Target Load = 1765 lb : Runs 13 − 18
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

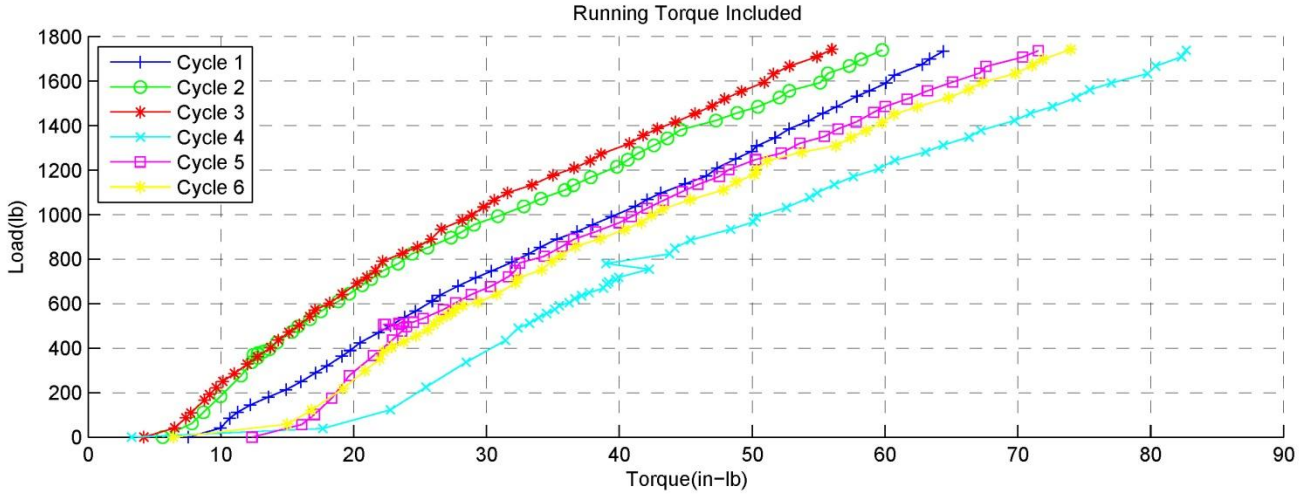

Torque vs. Load : Lubrication = Super Koropon
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = LD − MS51830CA201L : Insert State = Uncleaned : Target Load = 1765 lb : Runs 19 − 24
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
10
20
30
40
50
60
70

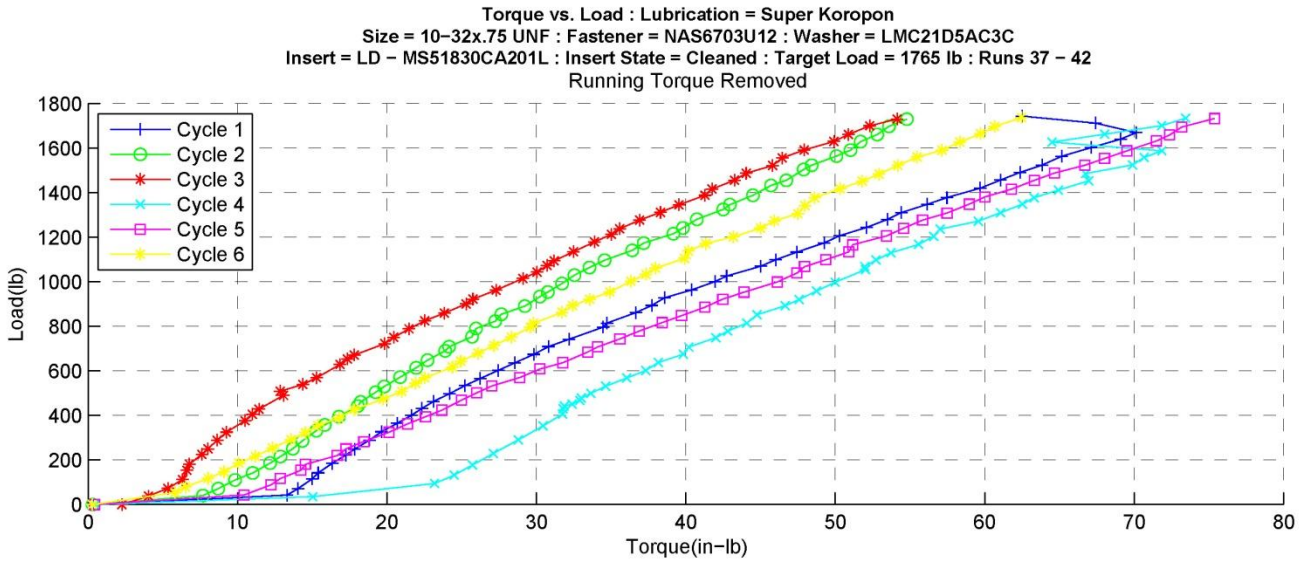

Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
10
20
30
40
50
60
70

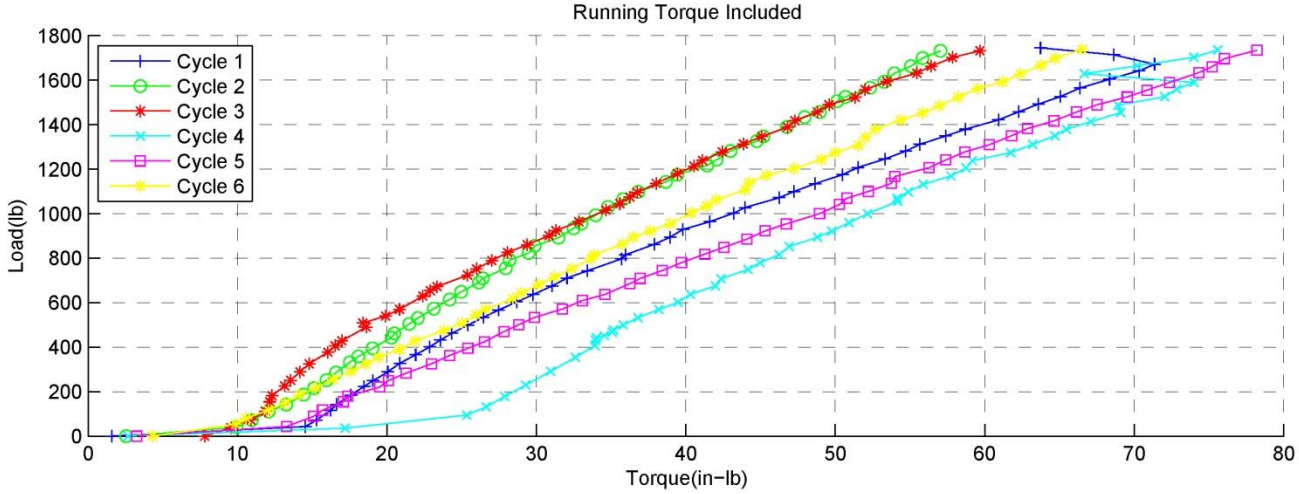

Torque vs. Load : Lubrication = Super Koropon
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = LD − MS51830CA201L : Insert State = Uncleaned : Target Load = 1765 lb : Runs 25 − 30
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
10
20
30
40
50
60
70

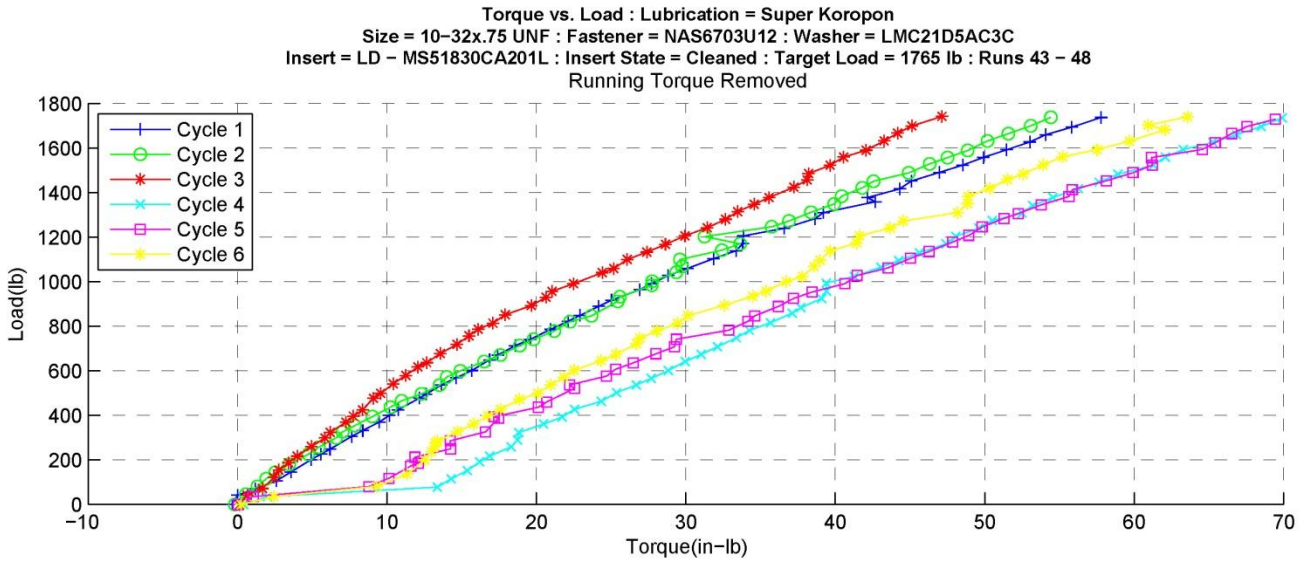

Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
10
20
30
40
50
60
70

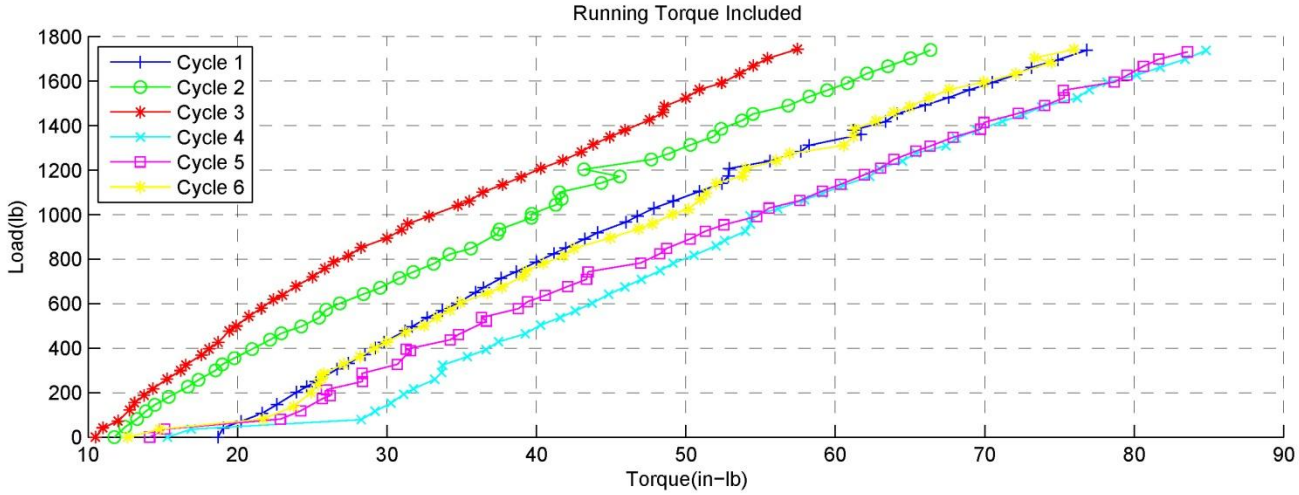

Torque vs. Load : Lubrication = Super Koropon
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = LD − MS51830CA201L : Insert State = Cleaned : Target Load = 1765 lb : Runs 31 − 36
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

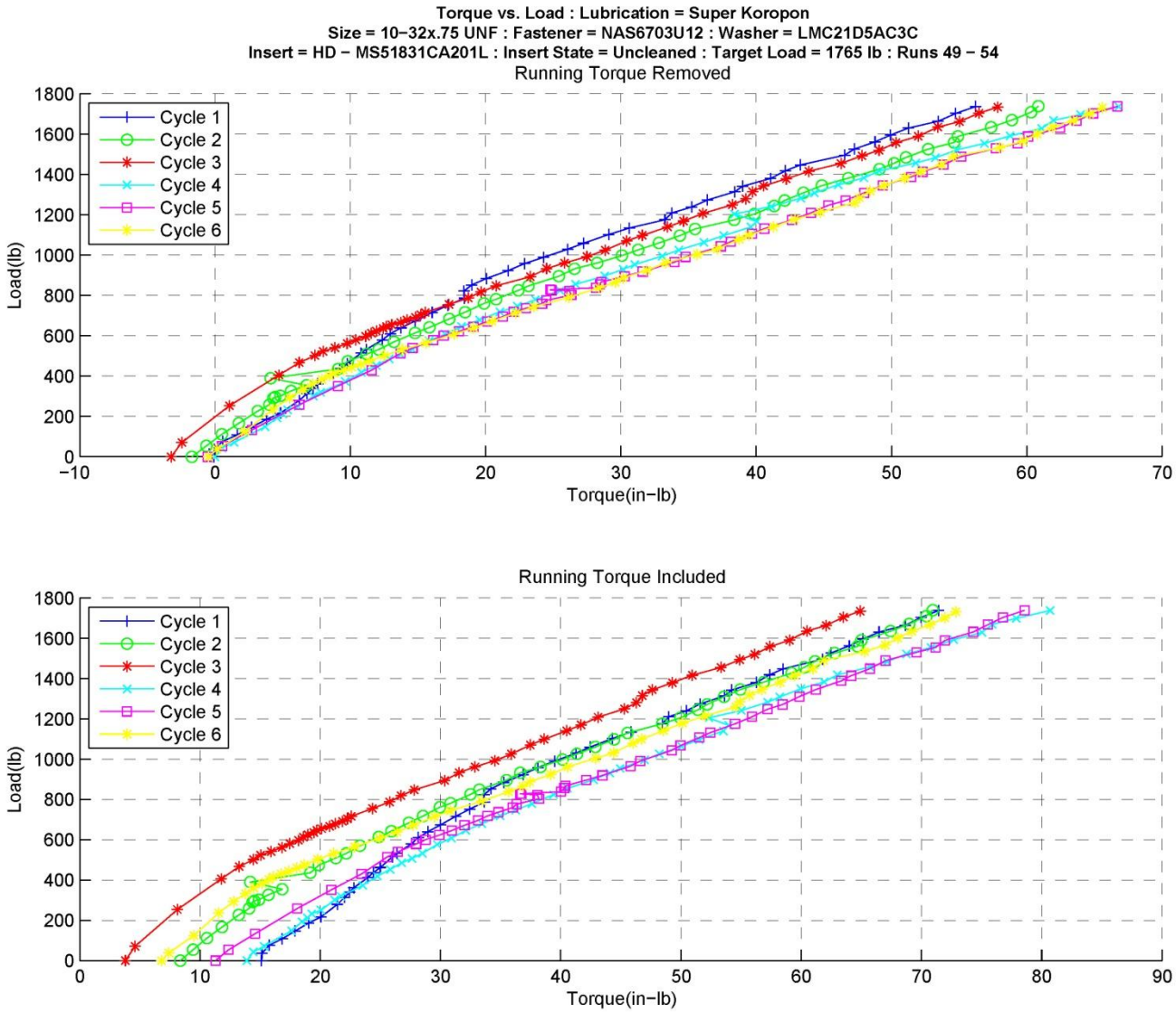

Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

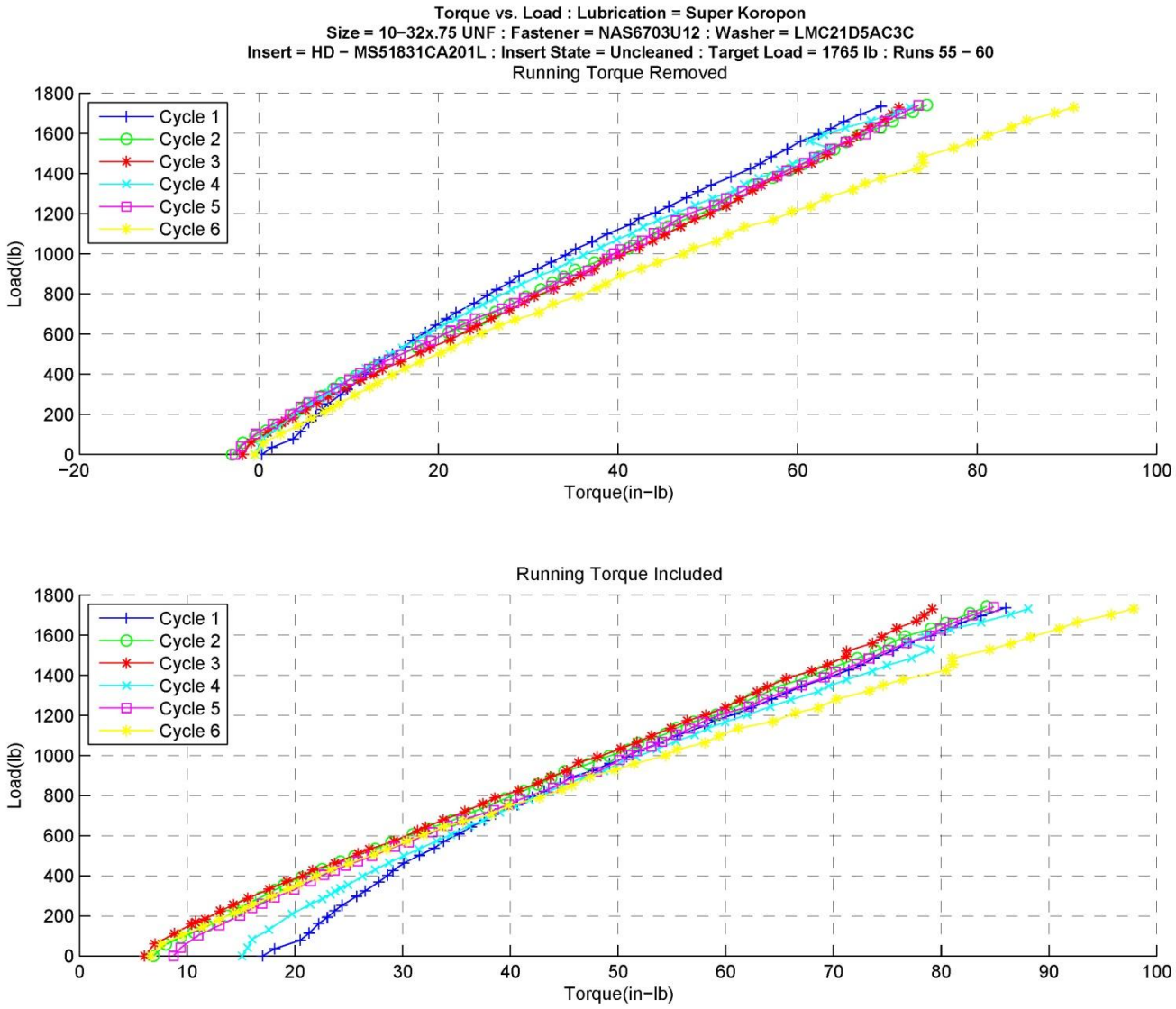

Torque vs. Load : Lubrication = Super Koropon
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = LD − MS51830CA201L : Insert State = Cleaned : Target Load = 1765 lb : Runs 37 − 42
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
10
20
30
40
50
60
70
80

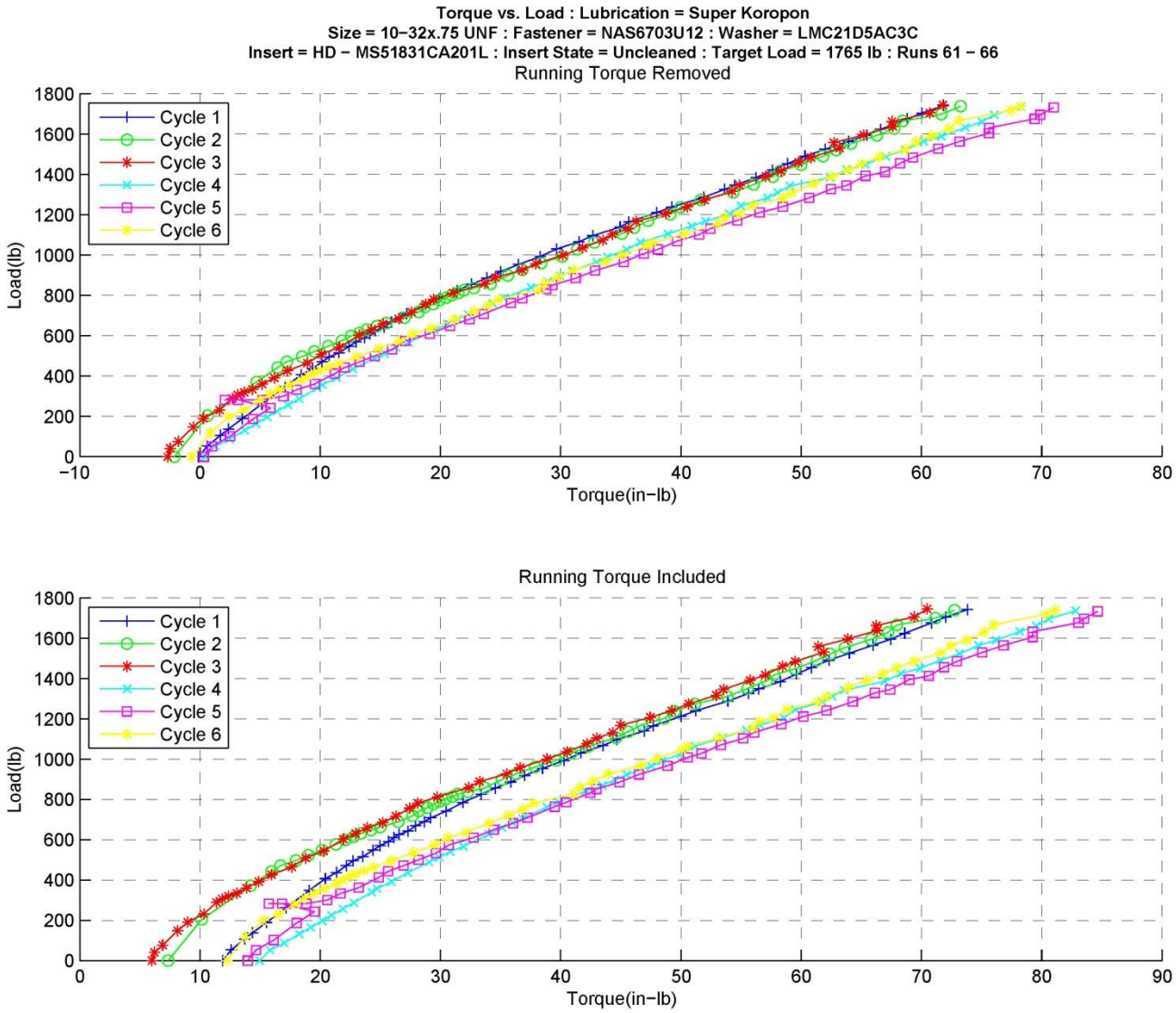

Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
10
20
30
40
50
60
70
80

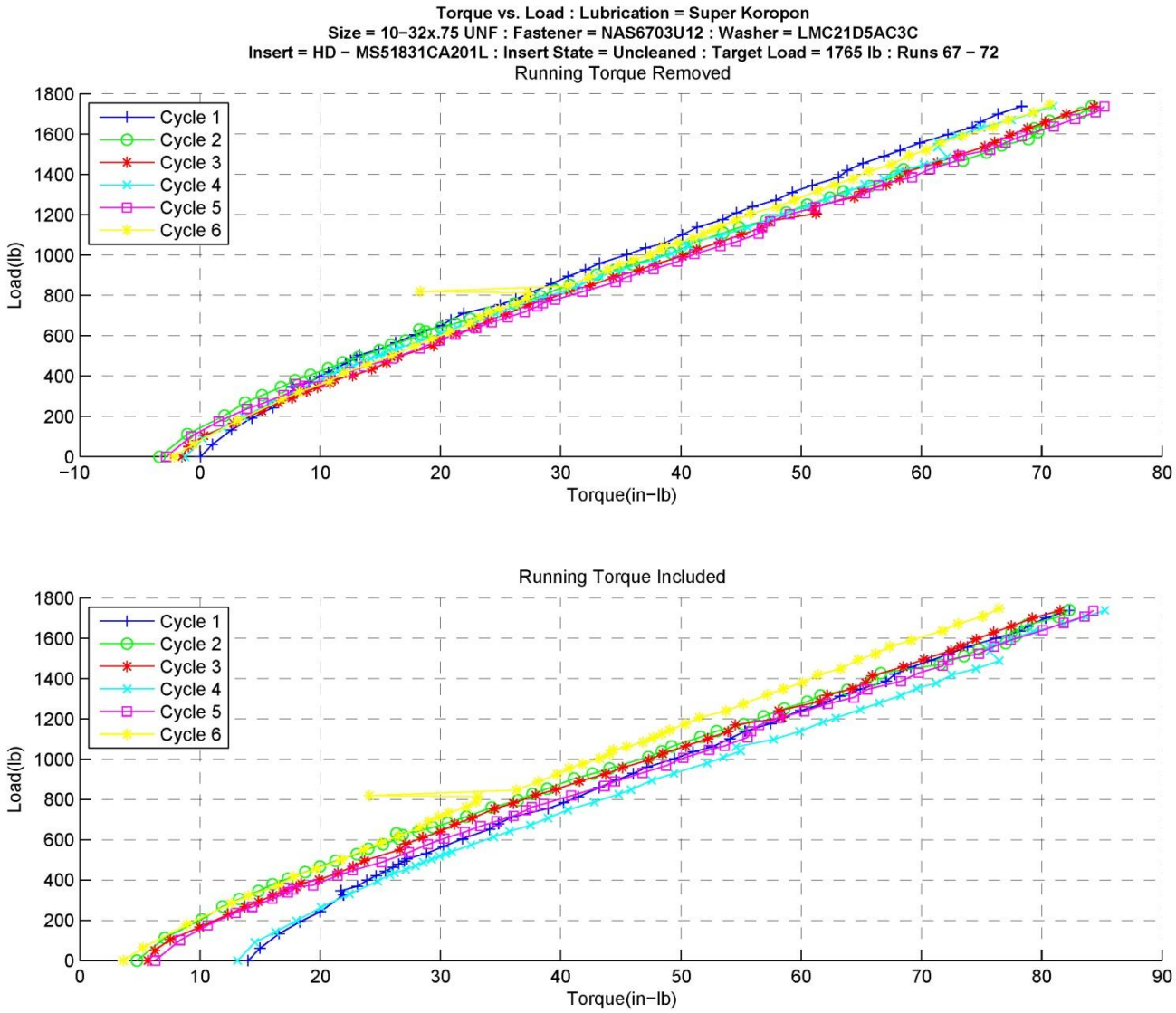

Torque vs. Load : Lubrication = Super Koropon
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = LD − MS51830CA201L : Insert State = Cleaned : Target Load = 1765 lb : Runs 43 − 48
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

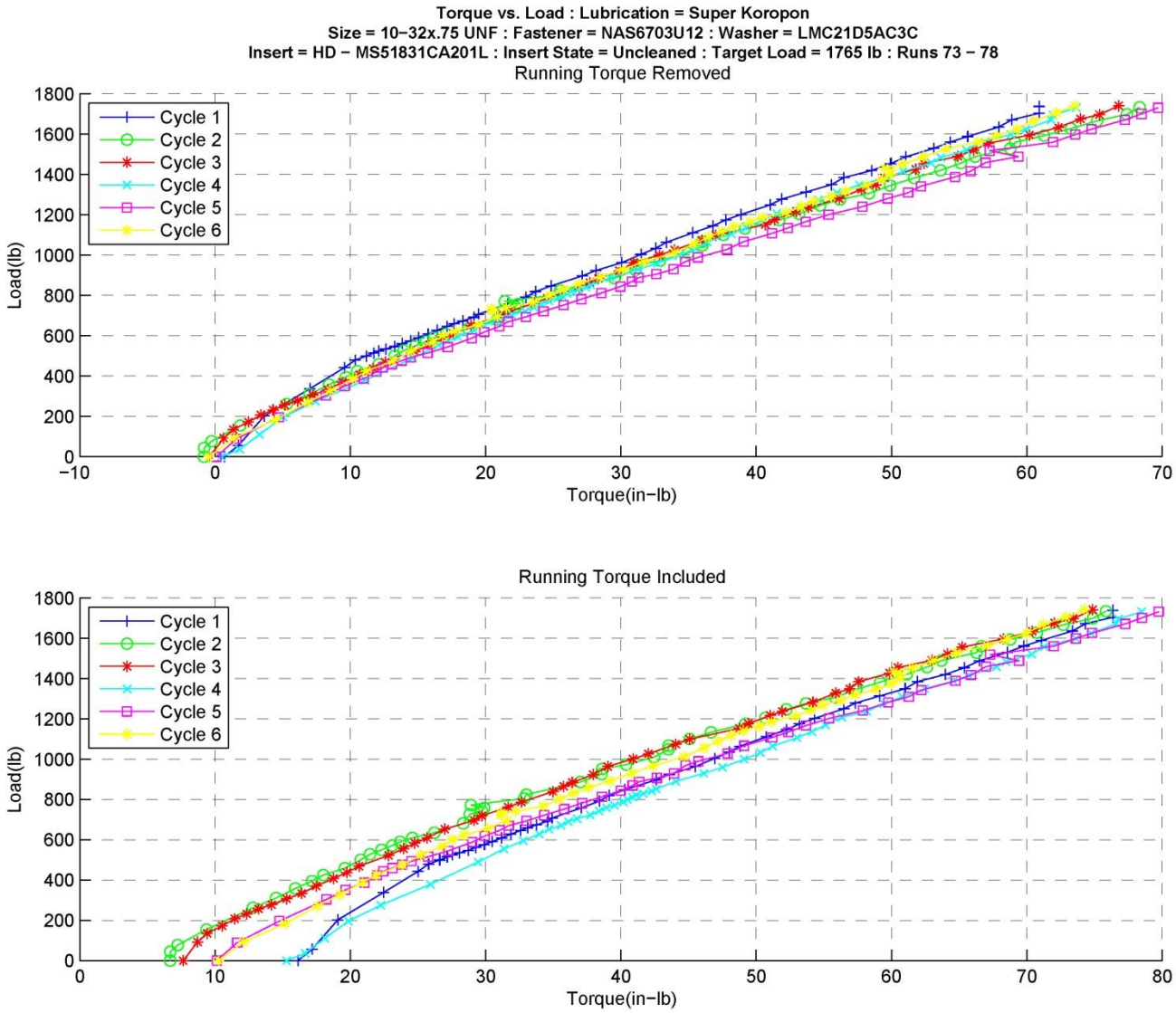

Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

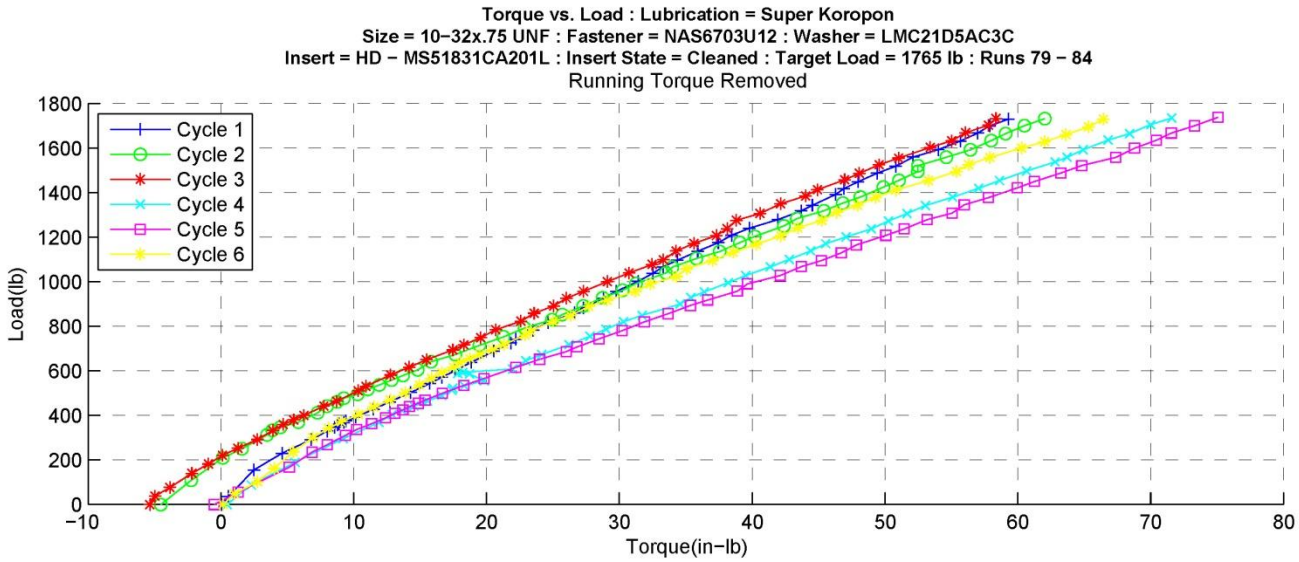

Torque vs. Load : Lubrication = Super Koropon
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = HD − MS51831CA201L : Insert State = Uncleaned : Target Load = 1765 lb : Runs 49 − 54
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

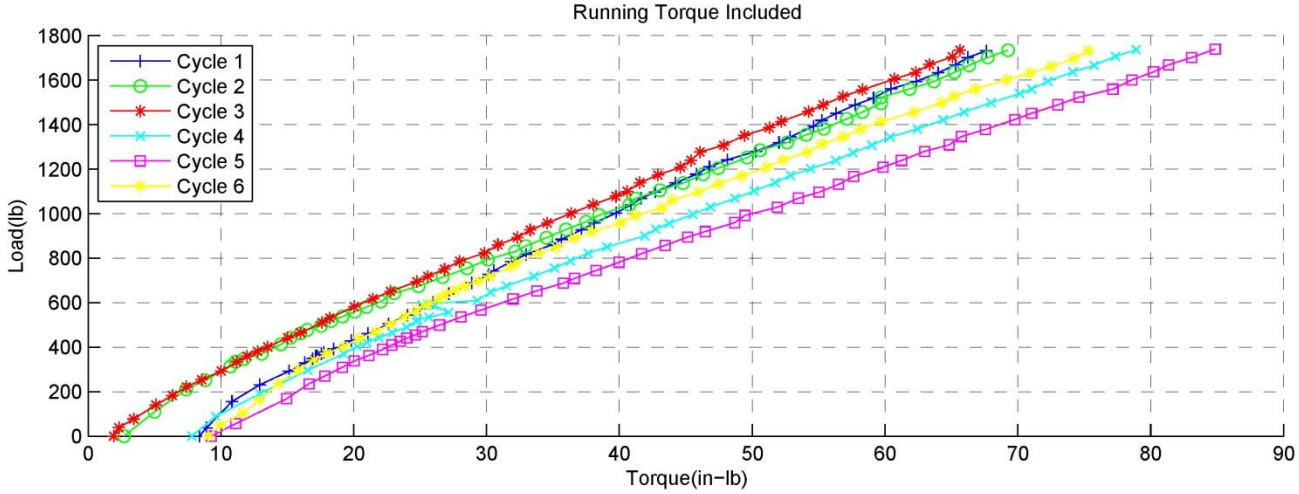

Torque vs. Load : Lubrication = Super Koropon
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = HD − MS51831CA201L : Insert State = Uncleaned : Target Load = 1765 lb : Runs 55 − 60
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

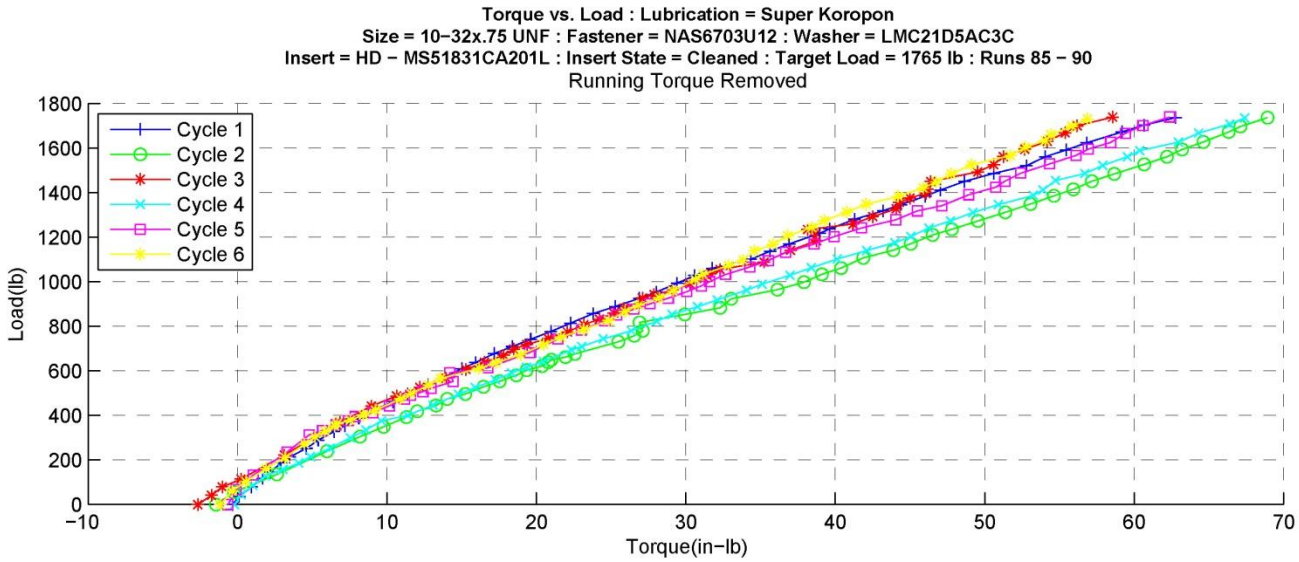

Torque vs. Load : Lubrication = Super Koropon
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = HD − MS51831CA201L : Insert State = Uncleaned : Target Load = 1765 lb : Runs 61 − 66
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

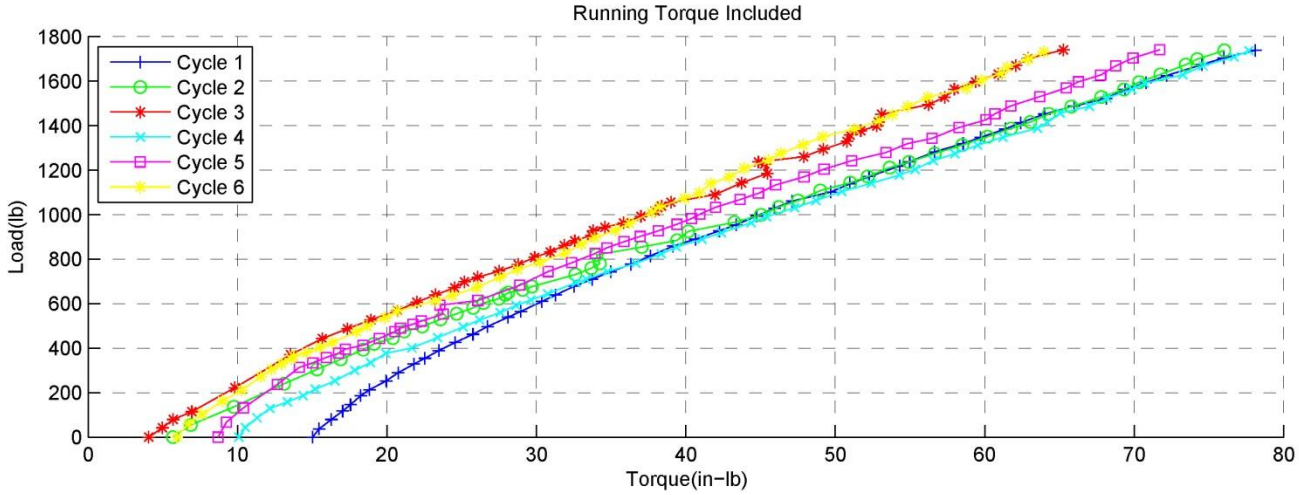

Torque vs. Load : Lubrication = Super Koropon
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = HD − MS51831CA201L : Insert State = Uncleaned : Target Load = 1765 lb : Runs 67 − 72
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

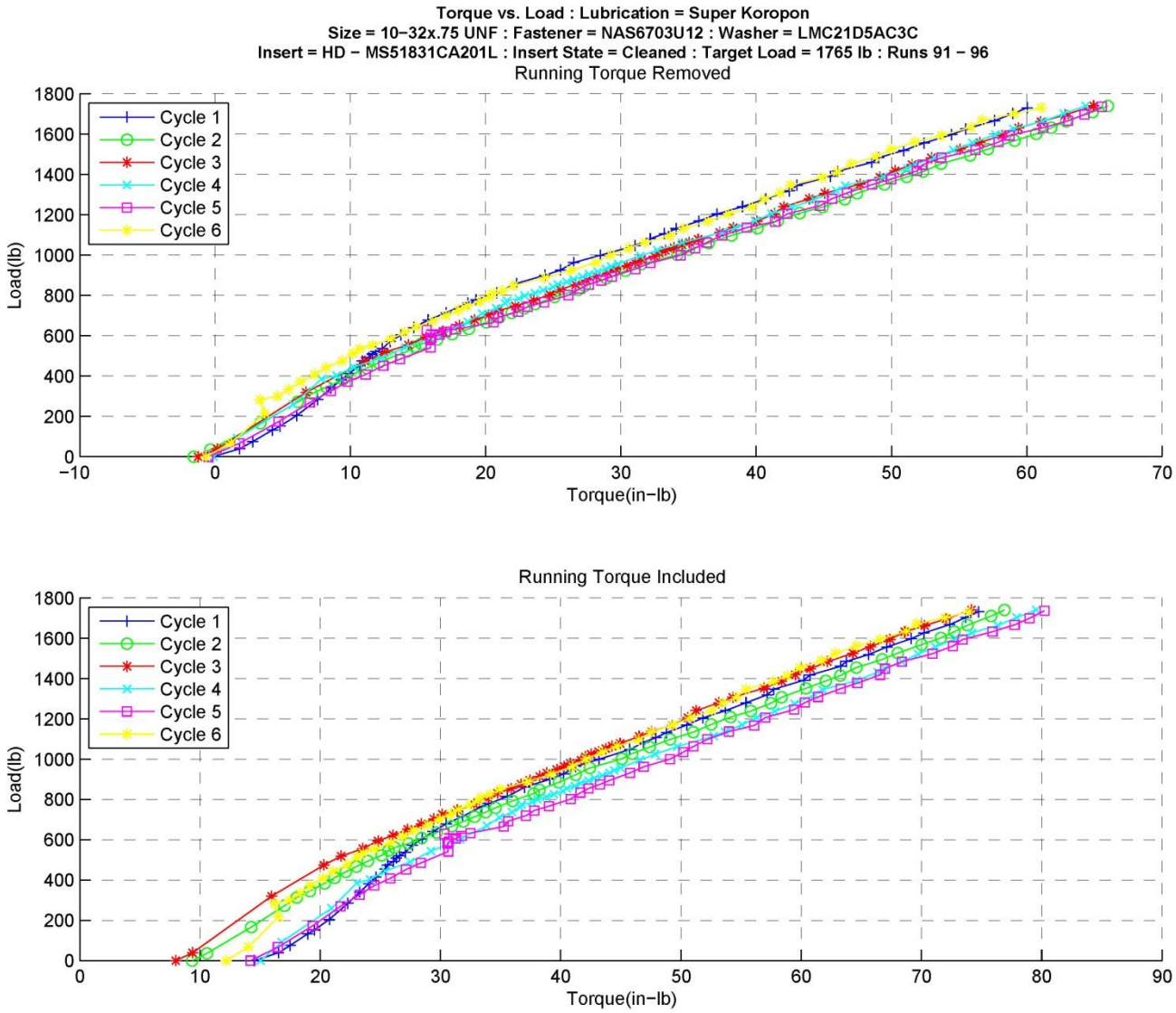

Torque vs. Load : Lubrication = Super Koropon
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = HD − MS51831CA201L : Insert State = Uncleaned : Target Load = 1765 lb : Runs 73 − 78
Running Torque Removed
Load(lb)
Torque(in−lb)
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Running Torque Included
Load(lb)
Torque(in−lb)
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6

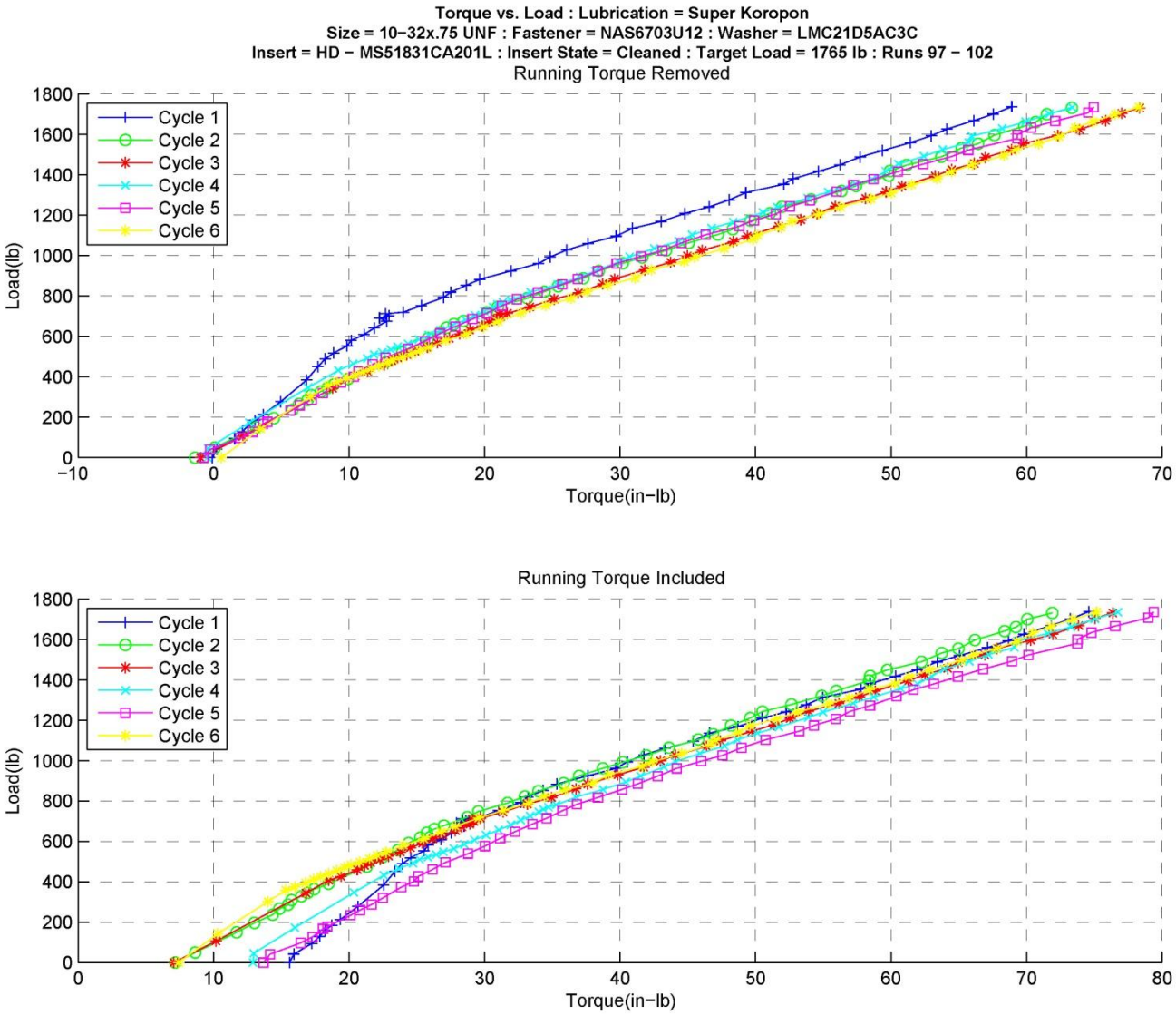

Torque vs. Load : Lubrication = Super Koropon
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = HD − MS51831CA201L : Insert State = Cleaned : Target Load = 1765 lb : Runs 79 − 84
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

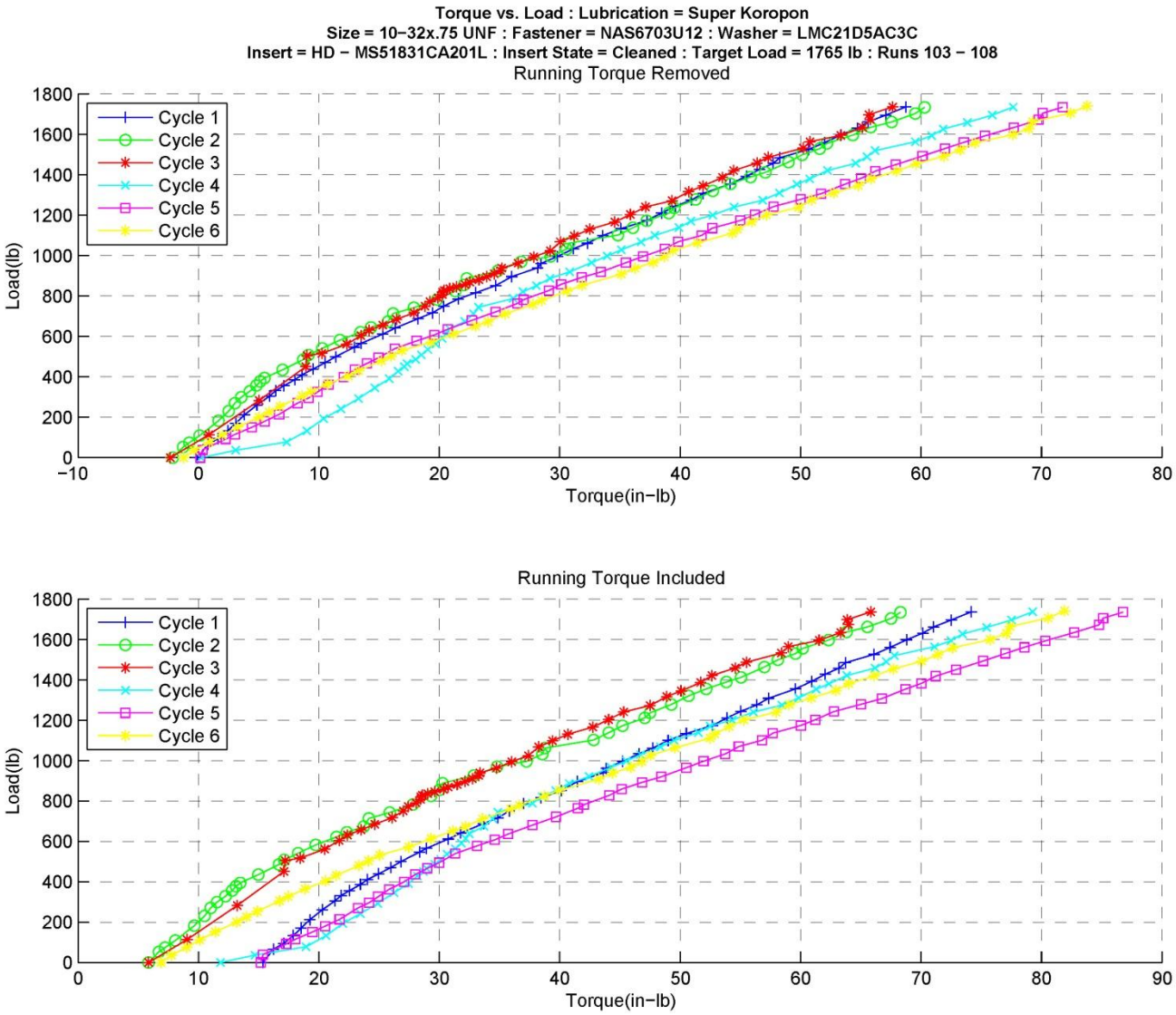

Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)


Torque vs. Load : Lubrication = Super Koropon
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = HD − MS51831CA201L : Insert State = Cleaned : Target Load = 1765 lb : Runs 85 − 90
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)


Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

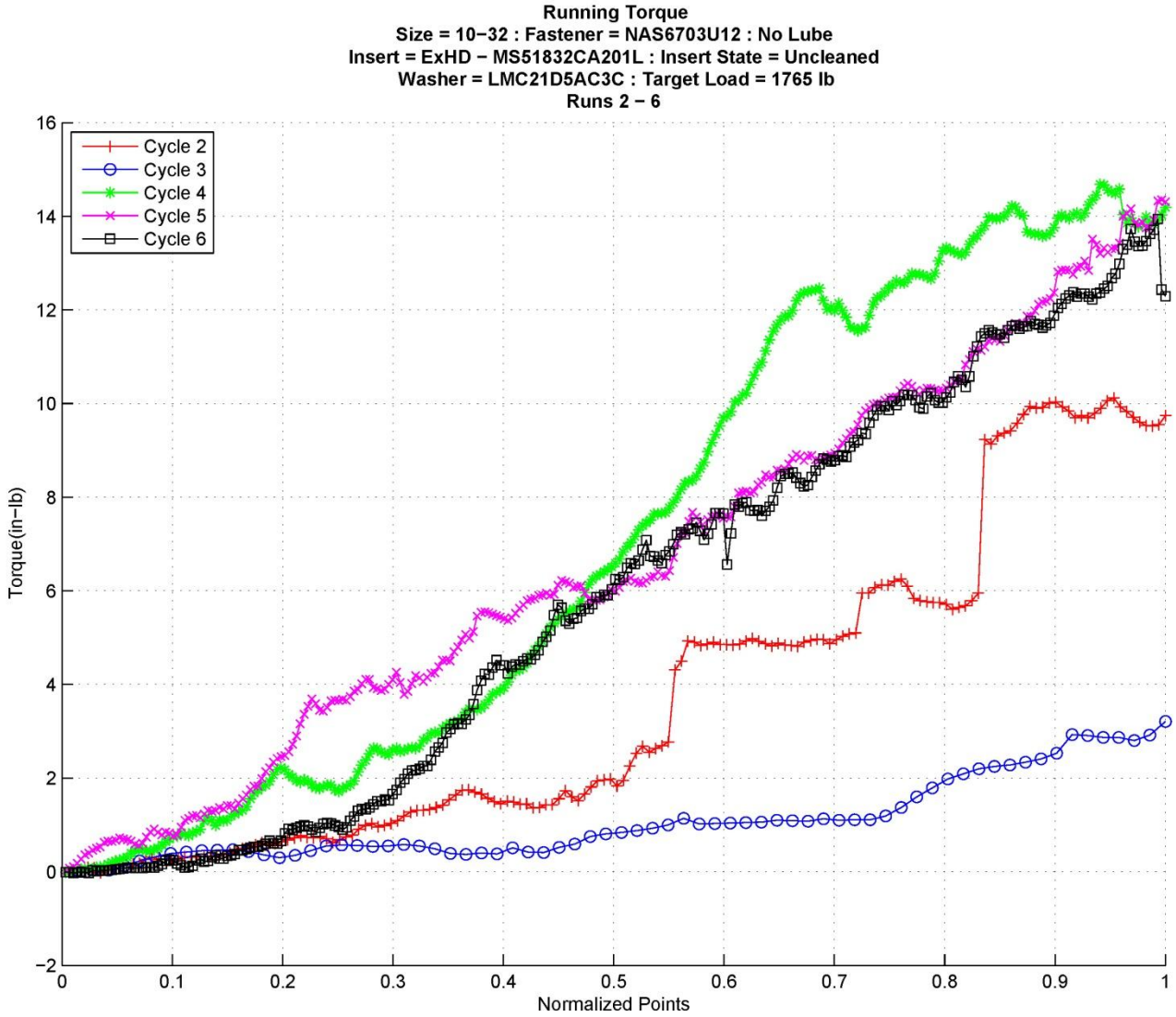

Torque vs. Load : Lubrication = Super Koropon
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = HD − MS51831CA201L : Insert State = Cleaned : Target Load = 1765 lb : Runs 91 − 96
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

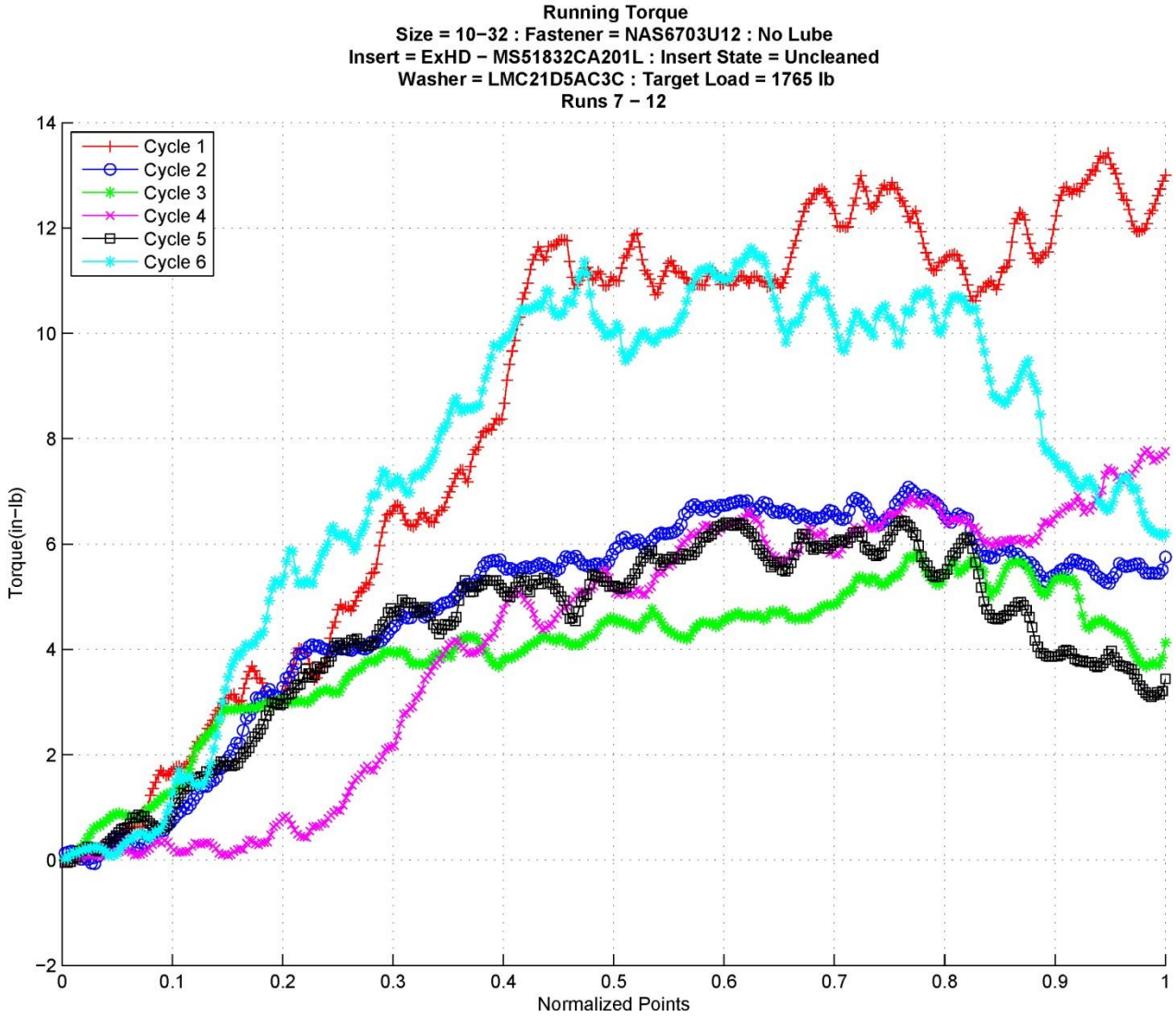

Torque vs. Load : Lubrication = Super Koropon
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = HD − MS51831CA201L : Insert State = Cleaned : Target Load = 1765 lb : Runs 97 − 102
Running Torque Removed
Load(lb)
Torque(in−lb)
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Running Torque Included
Load(lb)
Torque(in−lb)
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6

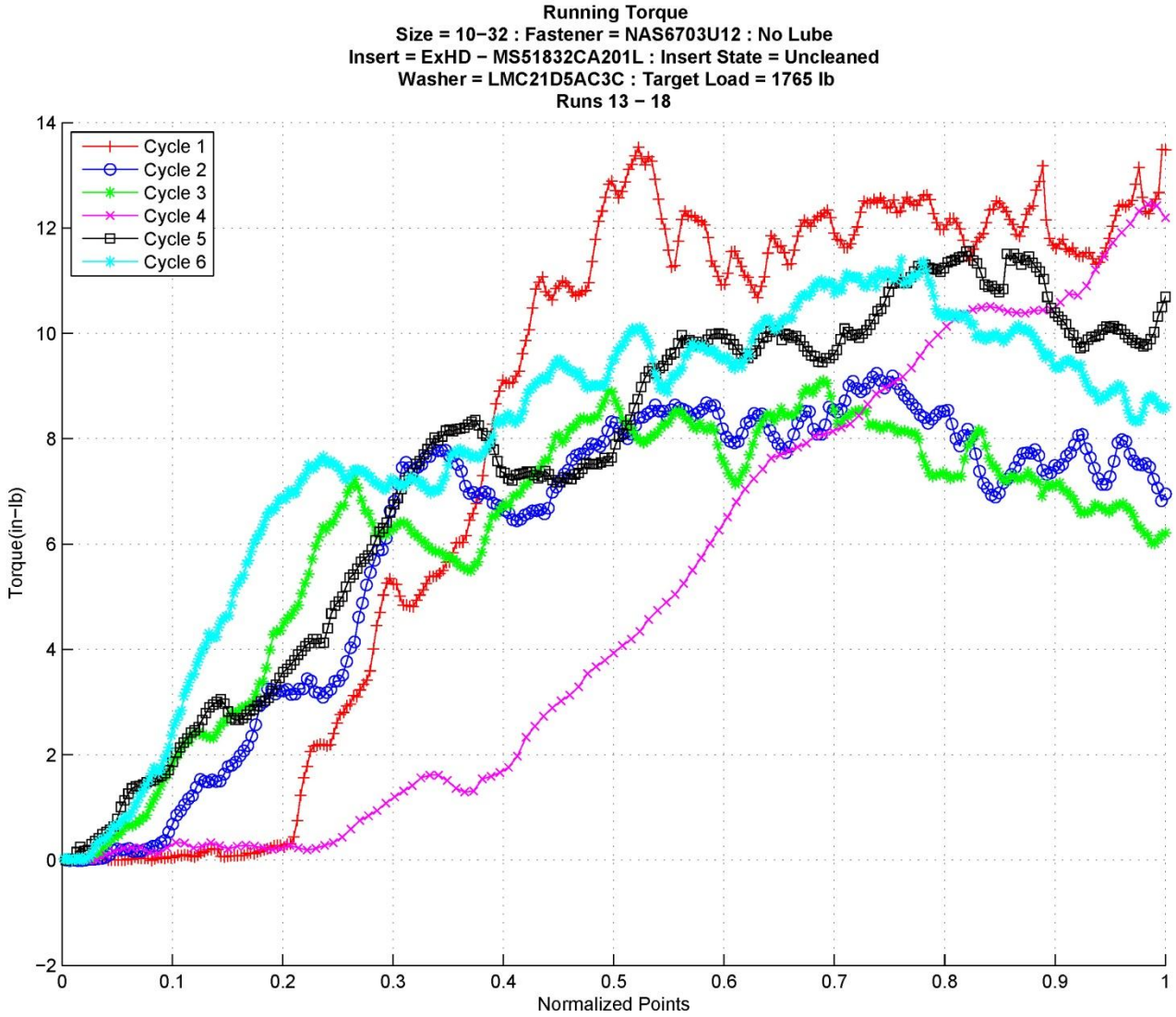

Torque vs. Load : Lubrication = Super Koropon
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Washer = LMC21D5AC3C
Insert = HD − MS51831CA201L : Insert State = Cleaned : Target Load = 1765 lb : Runs 103 − 108
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

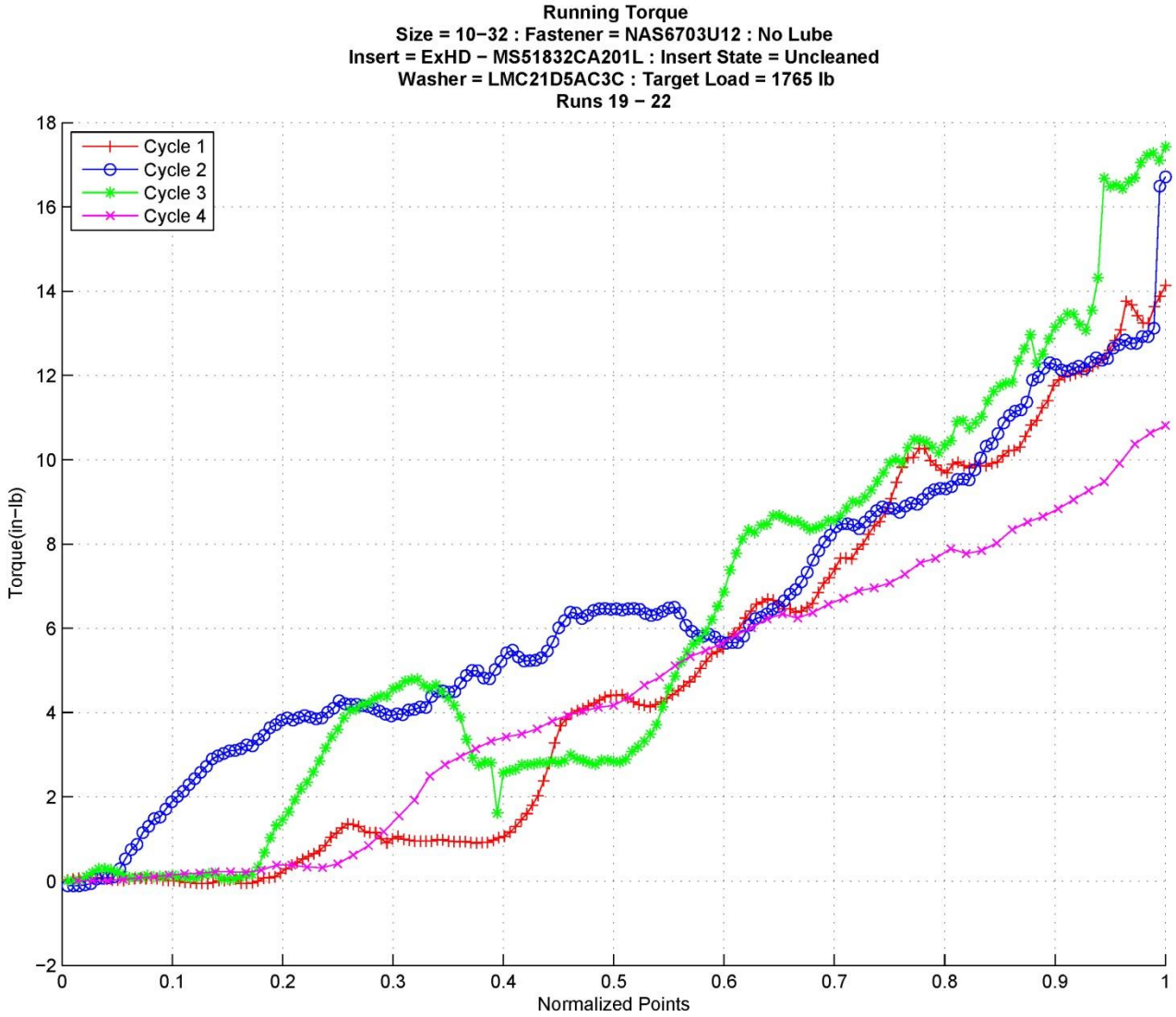
Appendix A:

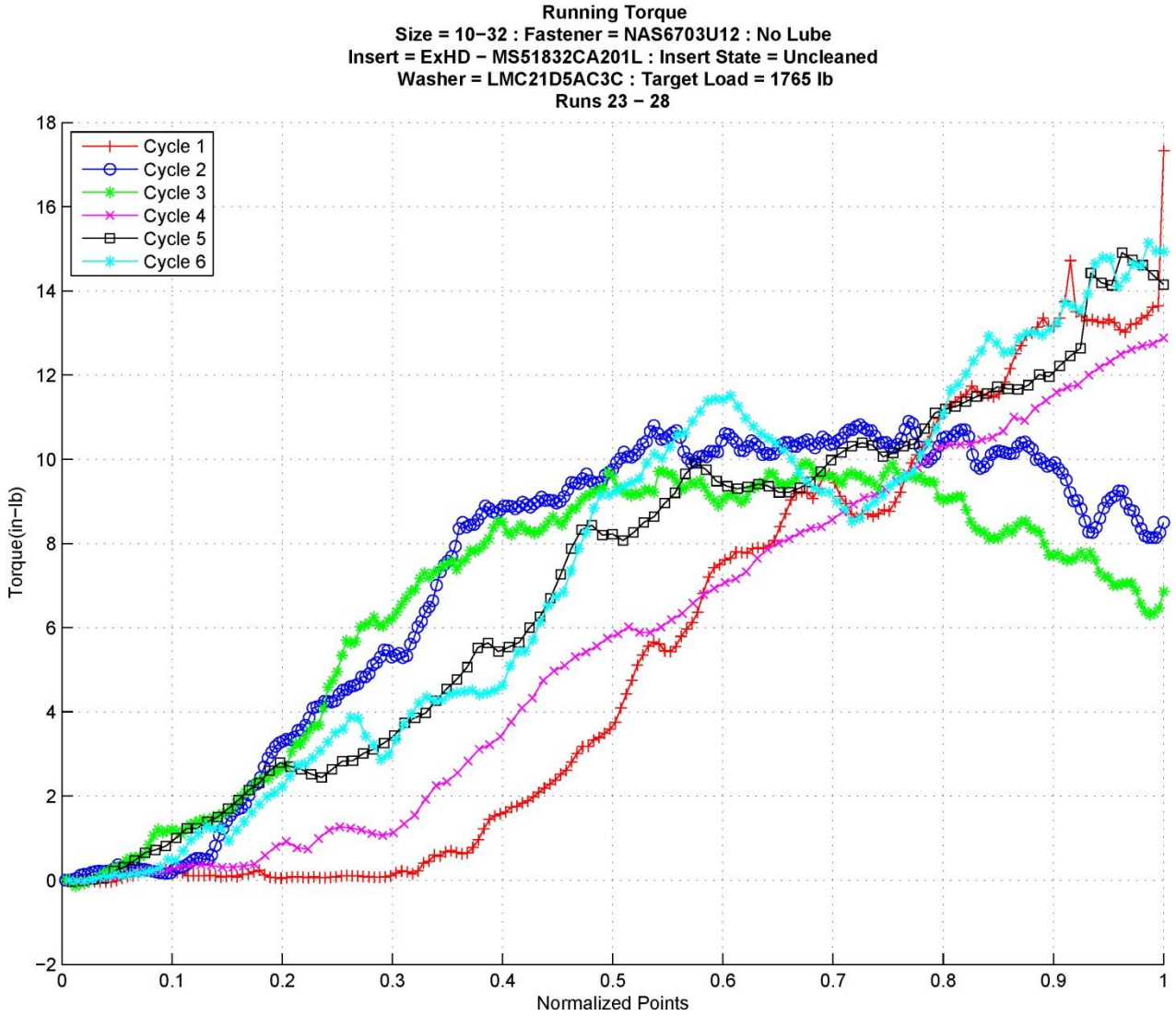
Section 1	10-32 Dry Torque Tension Plots
Section 2	10-32 Wet Torque Tension Plots
Section 3	10-32 Dry Running Torque Plots
Section 4	10-32 Wet Running Torque Plots
Section 5	10-32 Dry Cycle Plots: Torque vs. Load
Section 6	10-32 Wet Cycle Plots: Torque vs. Load
Section 7	10-32 Friction Coefficients
Section 8	10-32 Test Plate Layouts
Section 9	10-32 Dry Run Logs
Section 10	10-32 Wet Run Logs

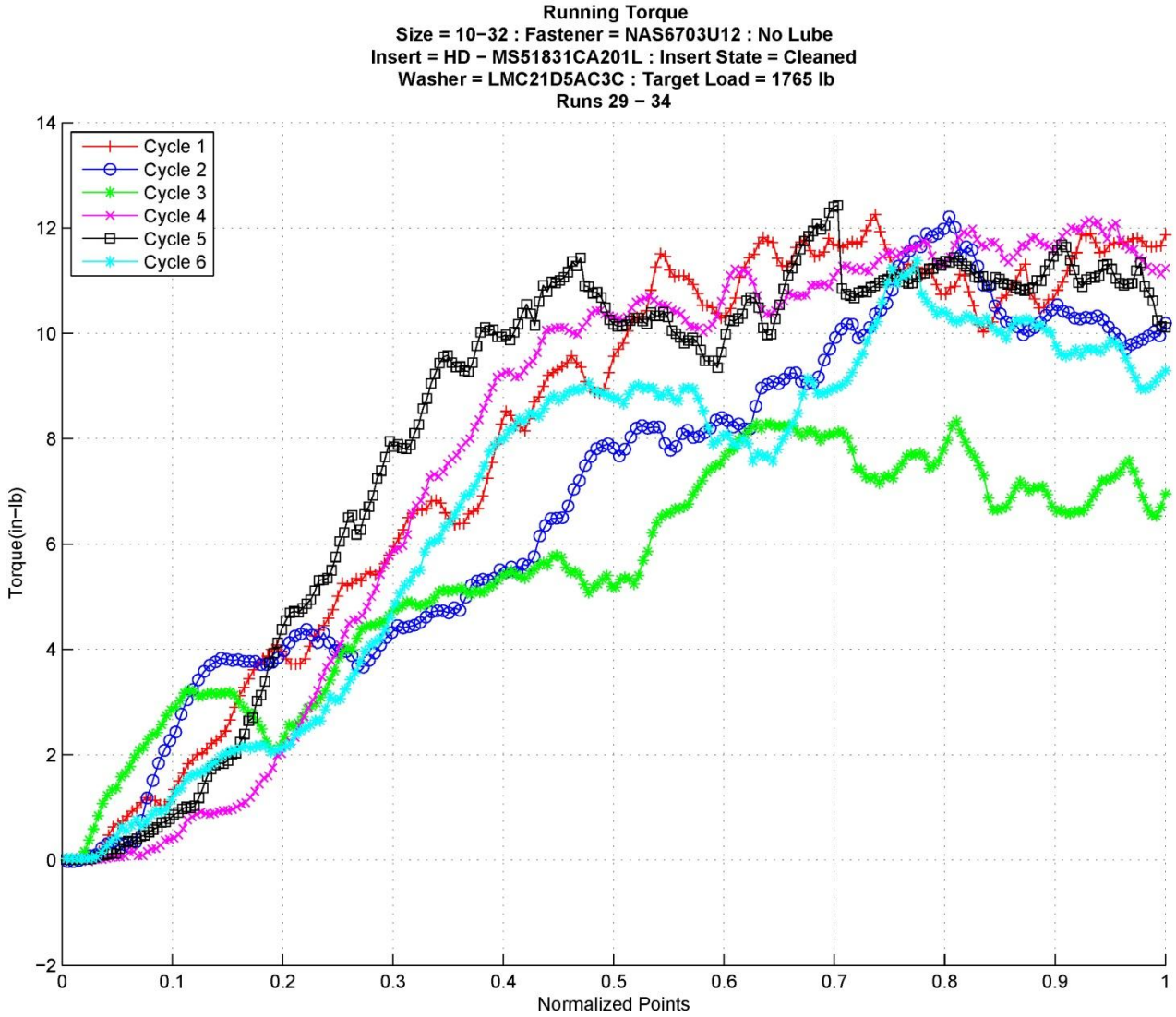

Running Torque
Size = 10−32 : Fastener = NAS6703U12 : No Lube
Insert = ExHD − MS51832CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 2 − 6
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
16
14
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

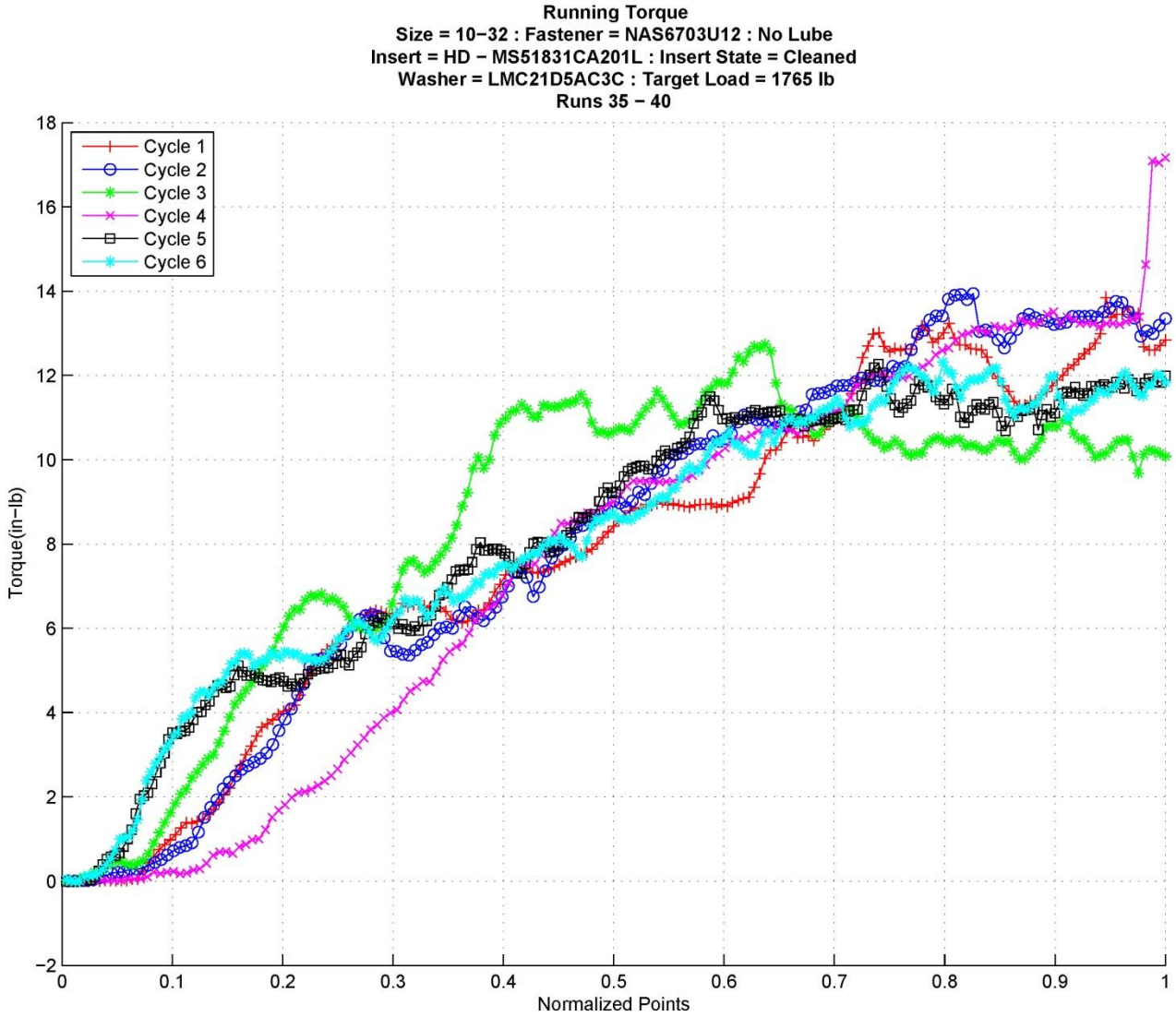

Running Torque
Size = 10−32 : Fastener = NAS6703U12 : No Lube
Insert = ExHD − MS51832CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 7 − 12
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
14
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

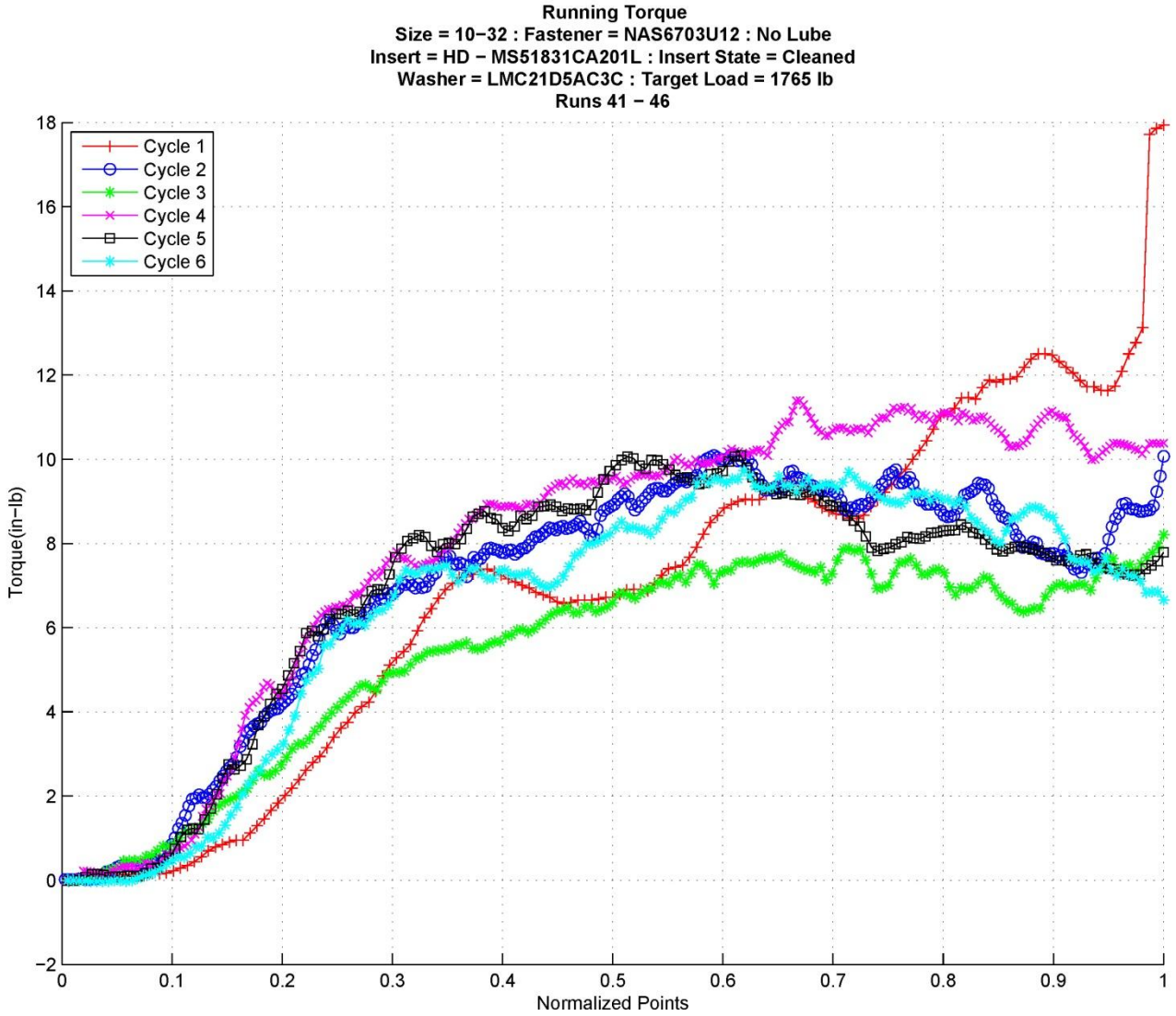

Running Torque
Size = 10−32 : Fastener = NAS6703U12 : No Lube
Insert = ExHD − MS51832CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 13 − 18
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
14
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

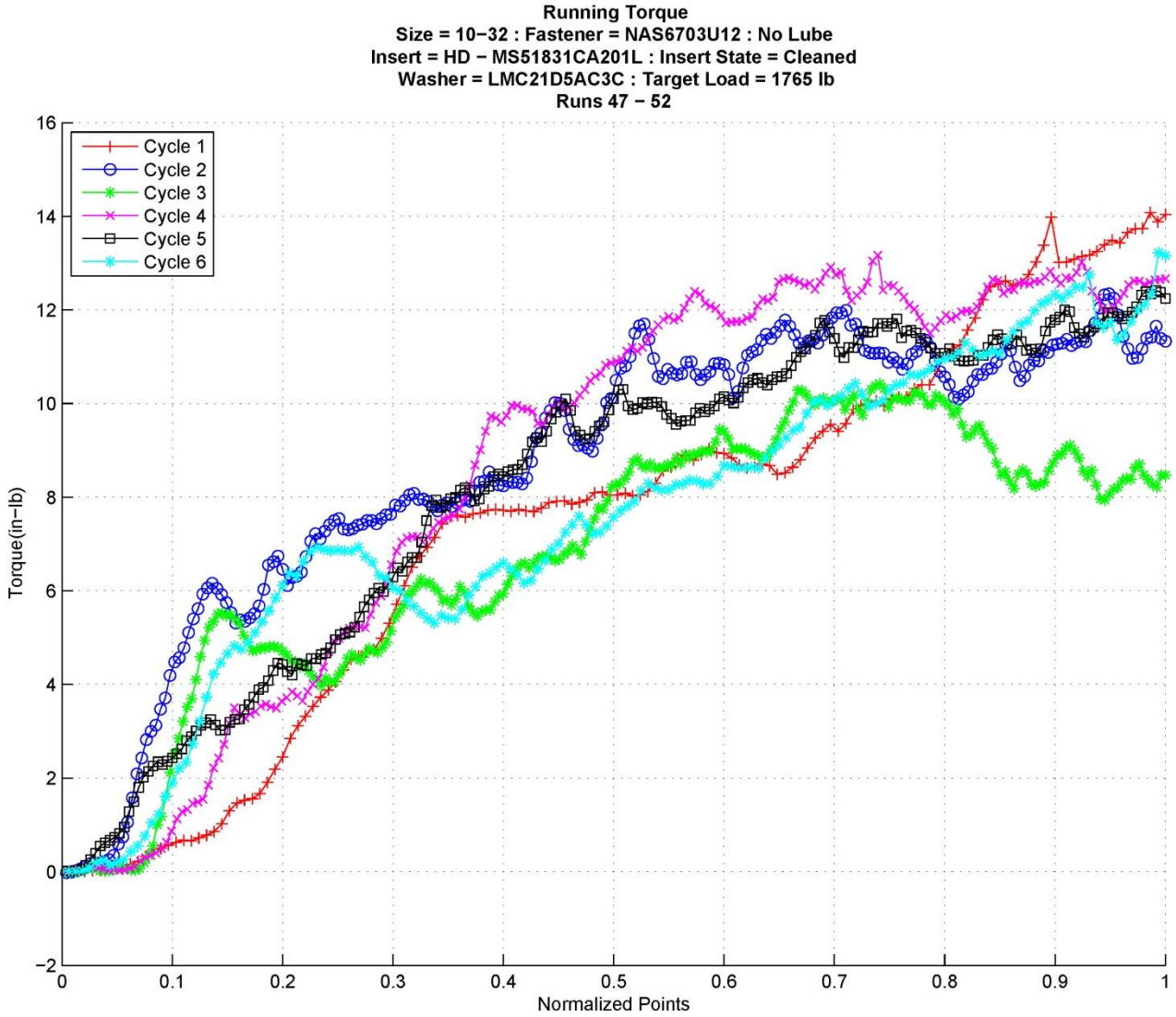

Running Torque
Size = 10−32 : Fastener = NAS6703U12 : No Lube
Insert = ExHD − MS51832CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 19 − 22
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Torque(in−lb)
Normalized Points
18
16
14
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

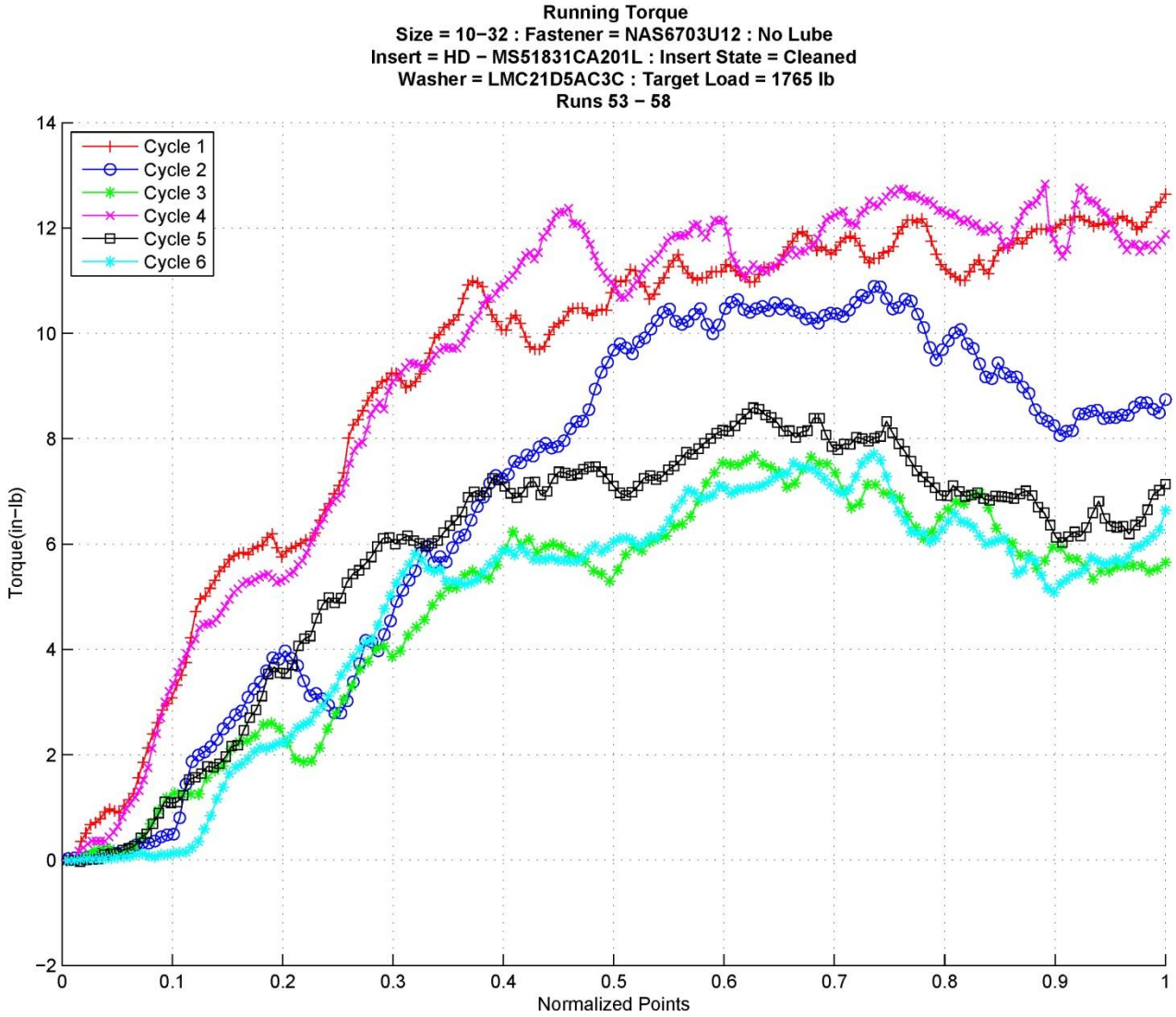

Running Torque
Size = 10−32 : Fastener = NAS6703U12 : No Lube
Insert = ExHD − MS51832CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 23 − 28
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
18
16
14
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

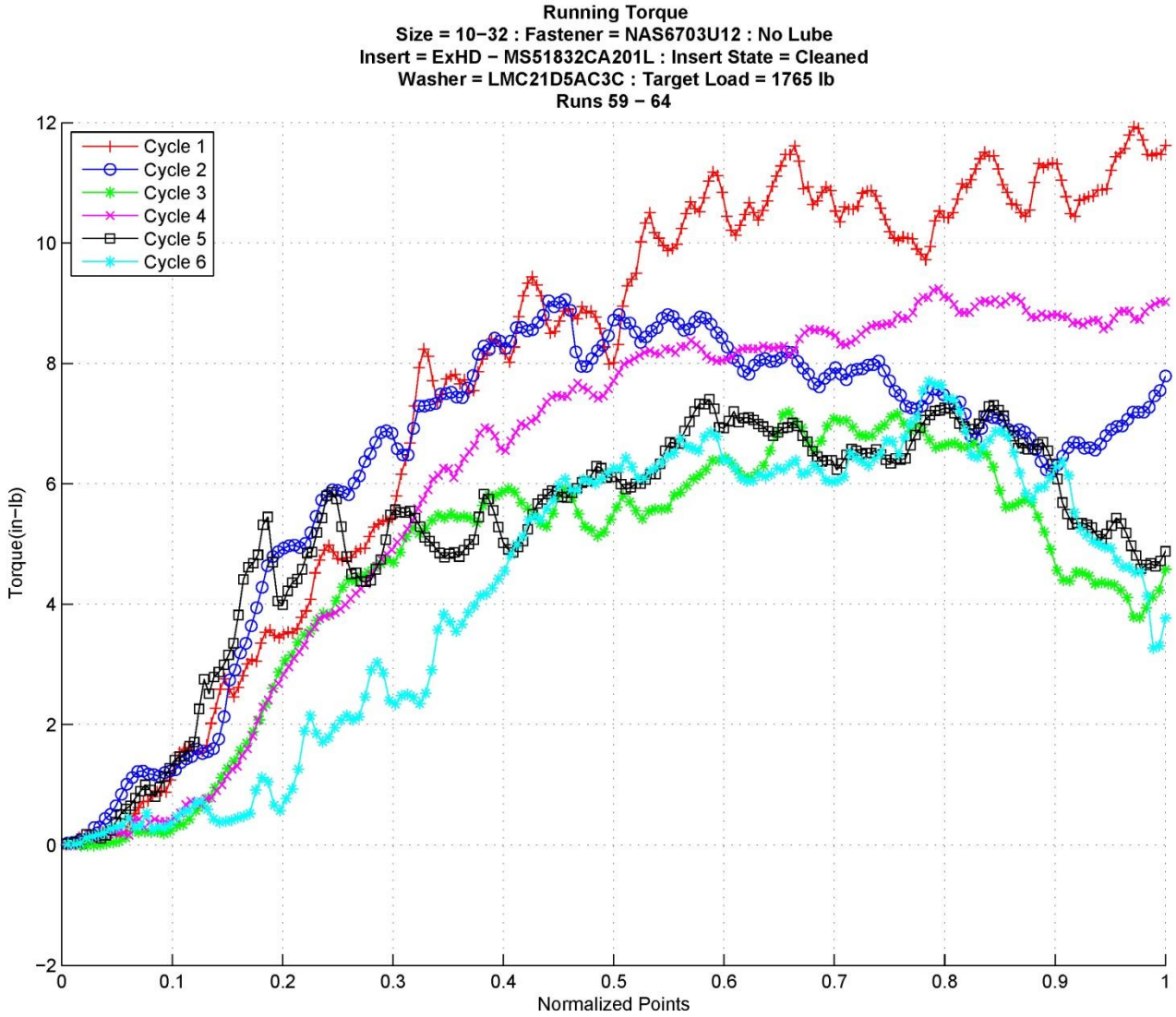

Running Torque
Size = 10−32 : Fastener = NAS6703U12 : No Lube
Insert = HD − MS51831CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 29 − 34
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
14
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

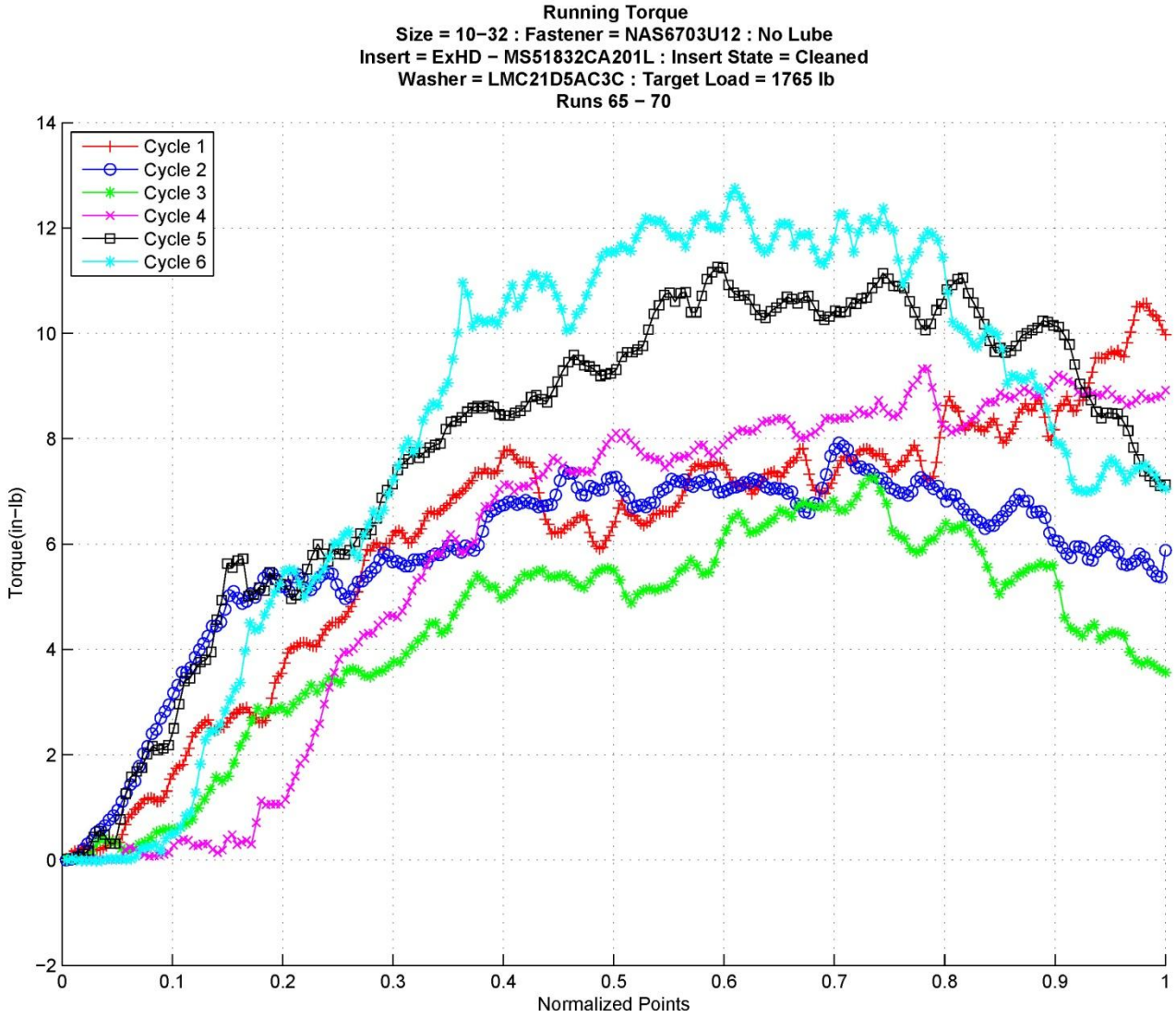

Running Torque
Size = 10−32 : Fastener = NAS6703U12 : No Lube
Insert = HD − MS51831CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 35 − 40
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
18
16
14
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

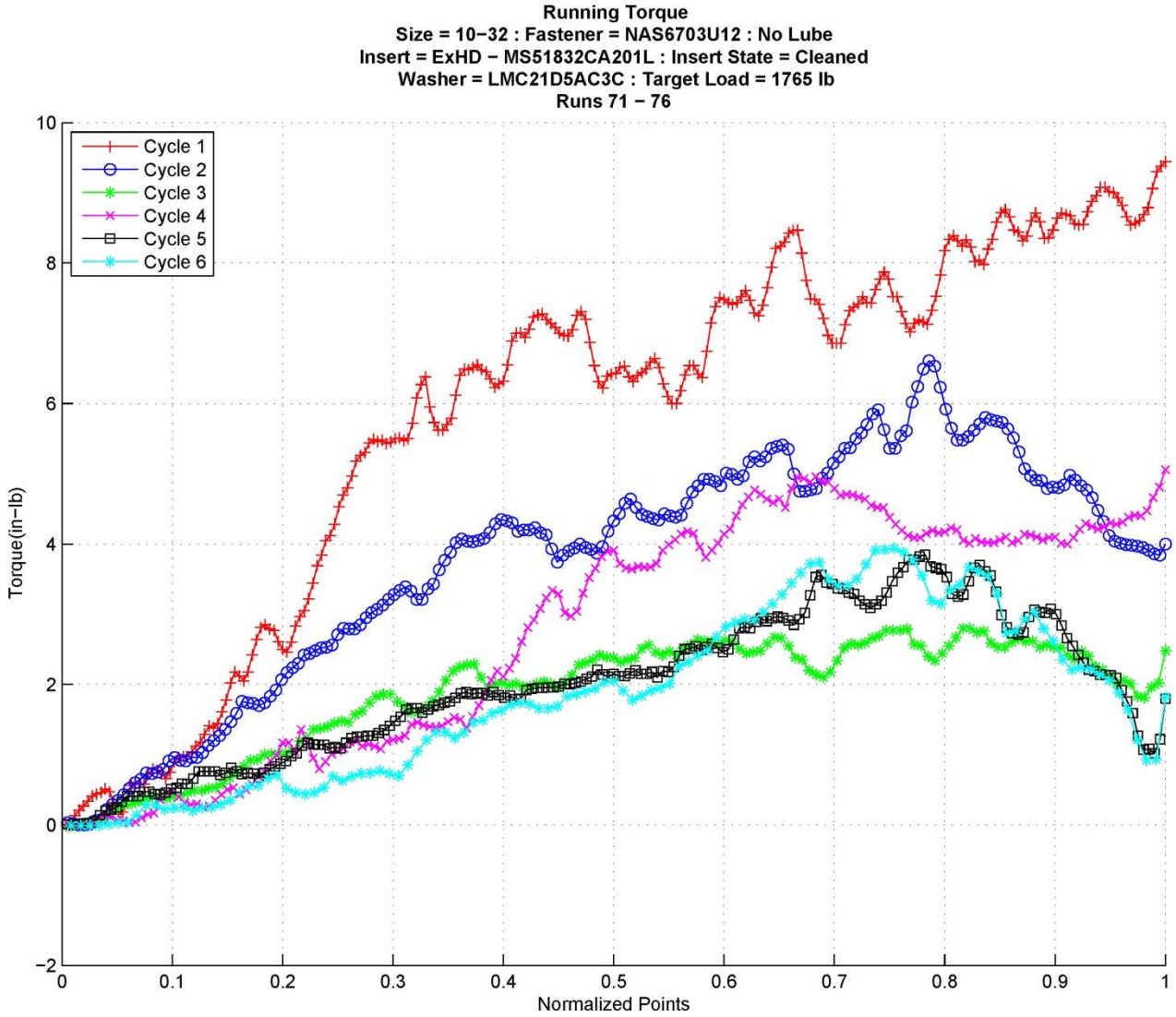

Running Torque
Size = 10−32 : Fastener = NAS6703U12 : No Lube
Insert = HD − MS51831CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 41 − 46
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
18
16
14
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

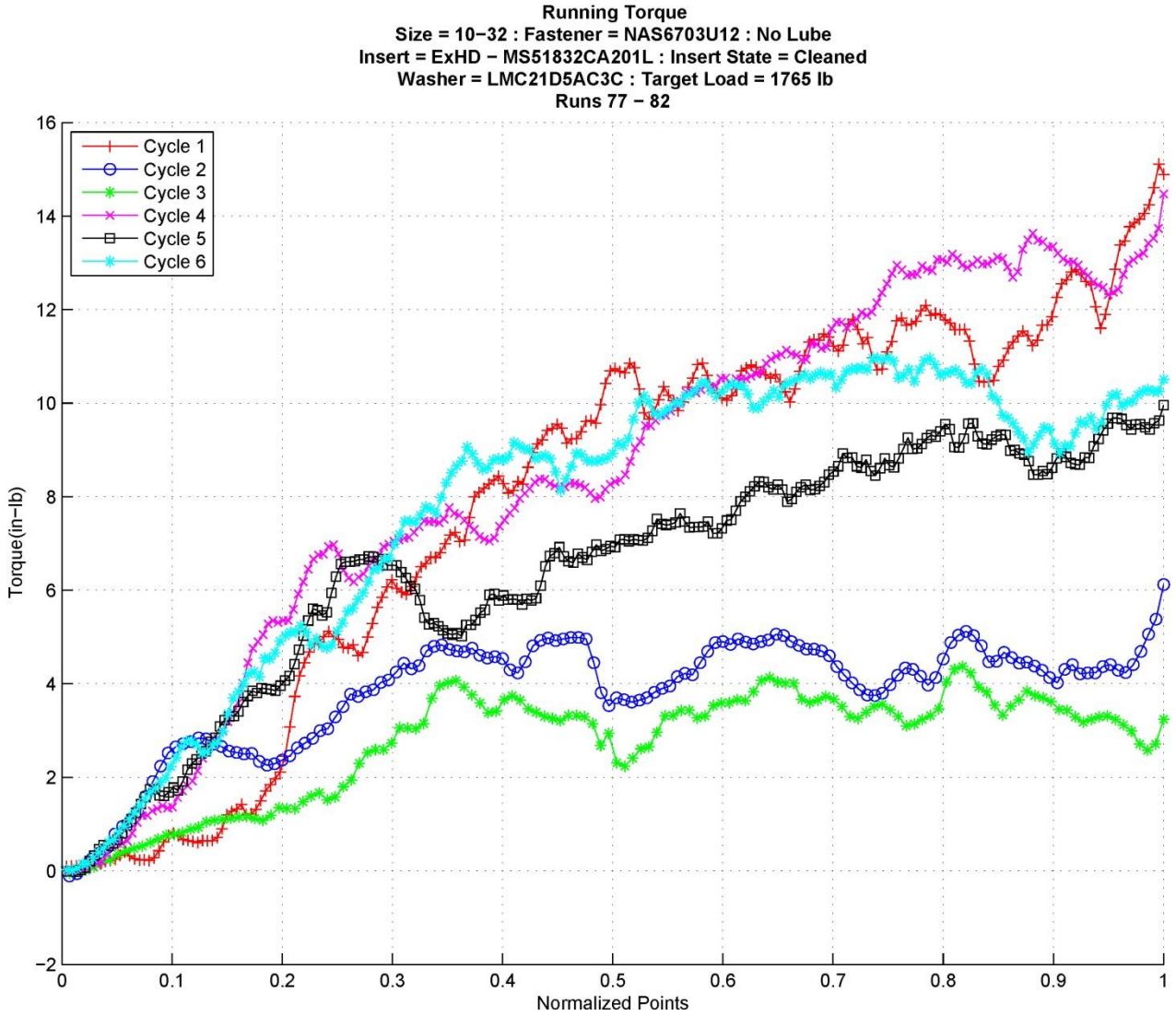

Running Torque
Size = 10−32 : Fastener = NAS6703U12 : No Lube
Insert = HD − MS51831CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 47 − 52
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
16
14
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


Running Torque
Size = 10−32 : Fastener = NAS6703U12 : No Lube
Insert = HD − MS51831CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 53 − 58
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
14
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


Running Torque
Size = 10−32 : Fastener = NAS6703U12 : No Lube
Insert = ExHD − MS51832CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 59 − 64
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

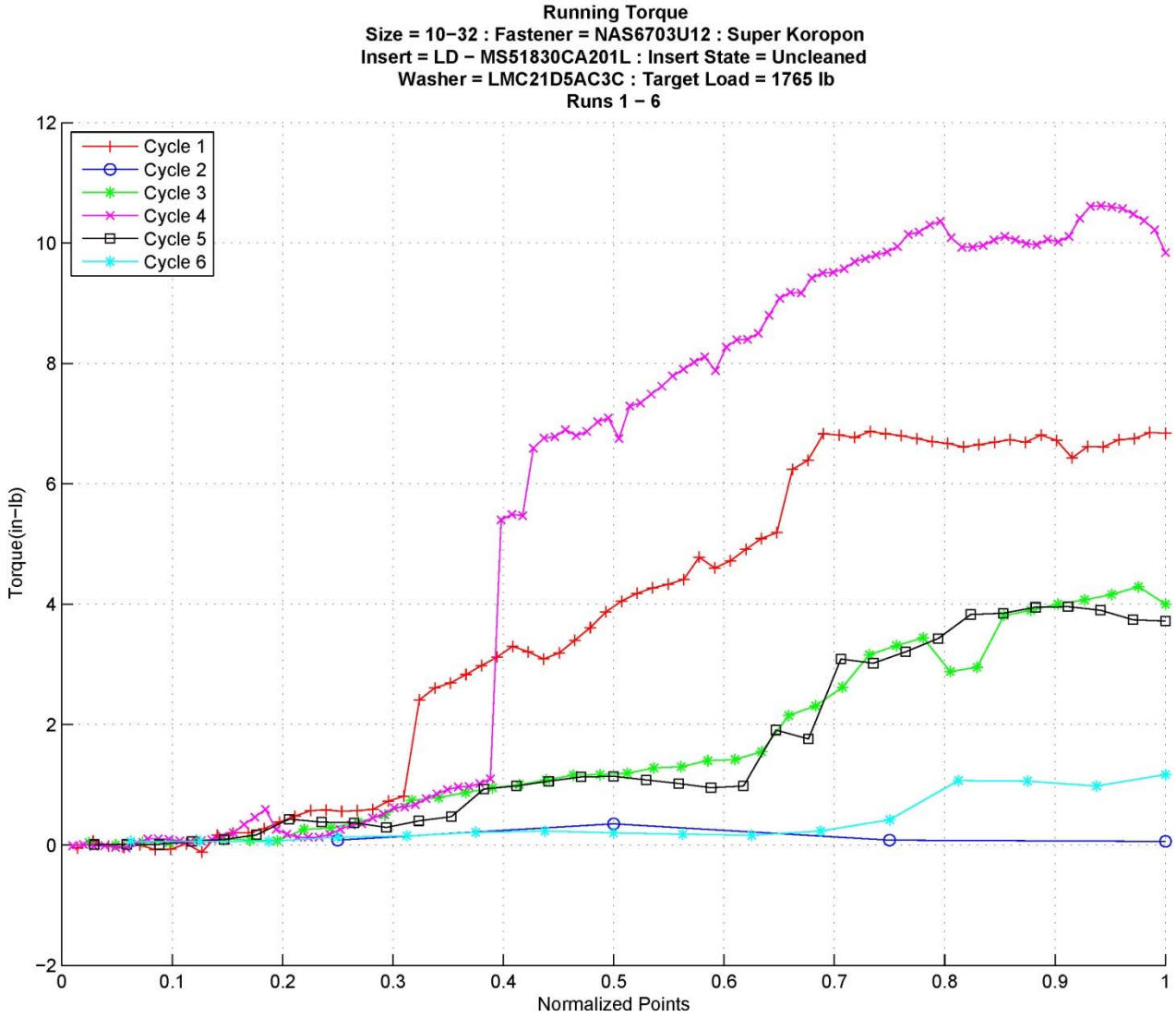

Running Torque
Size = 10−32 : Fastener = NAS6703U12 : No Lube
Insert = ExHD − MS51832CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 65 − 70
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
14
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

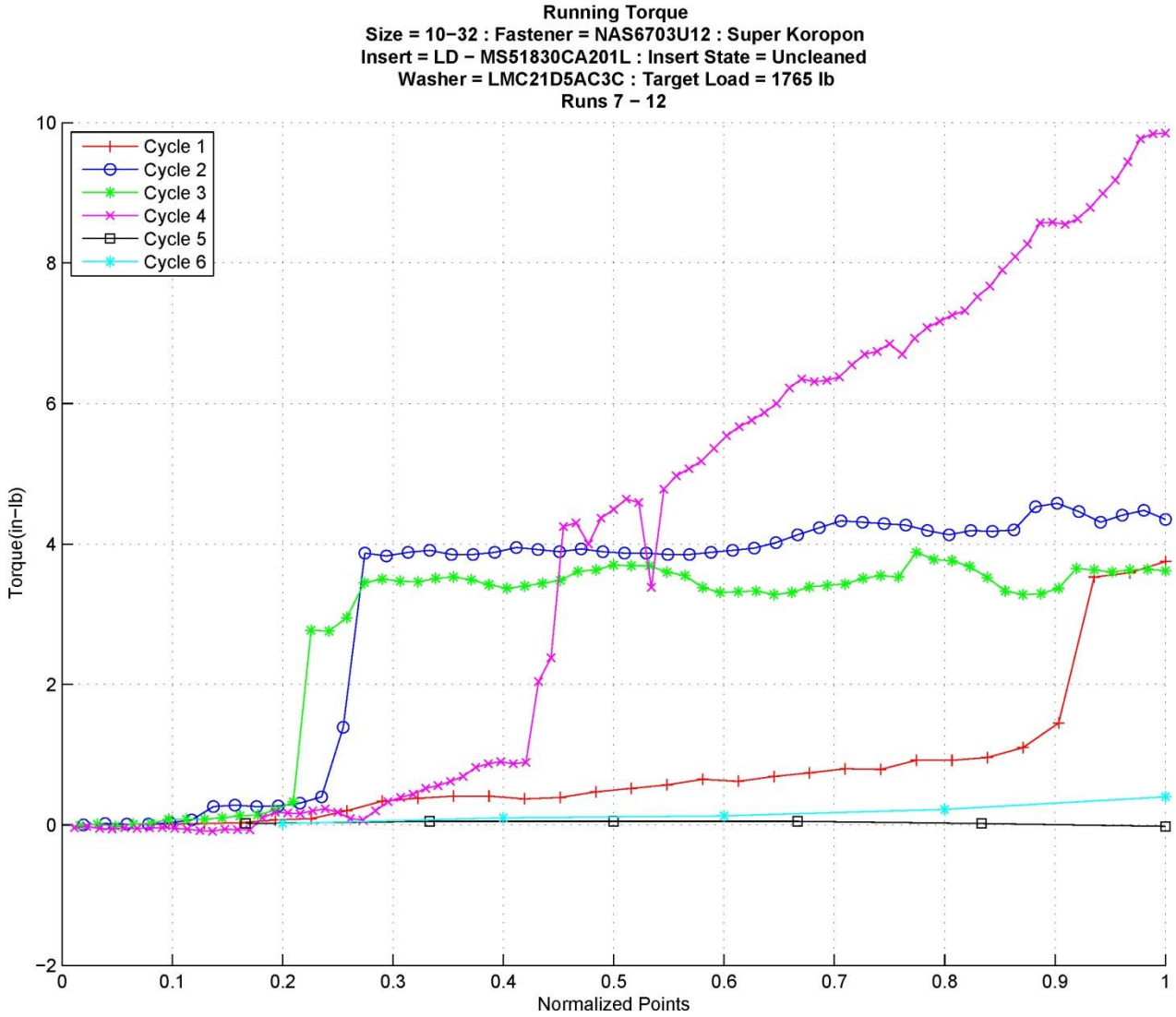

Running Torque
Size = 10−32 : Fastener = NAS6703U12 : No Lube
Insert = ExHD − MS51832CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 71 − 76
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

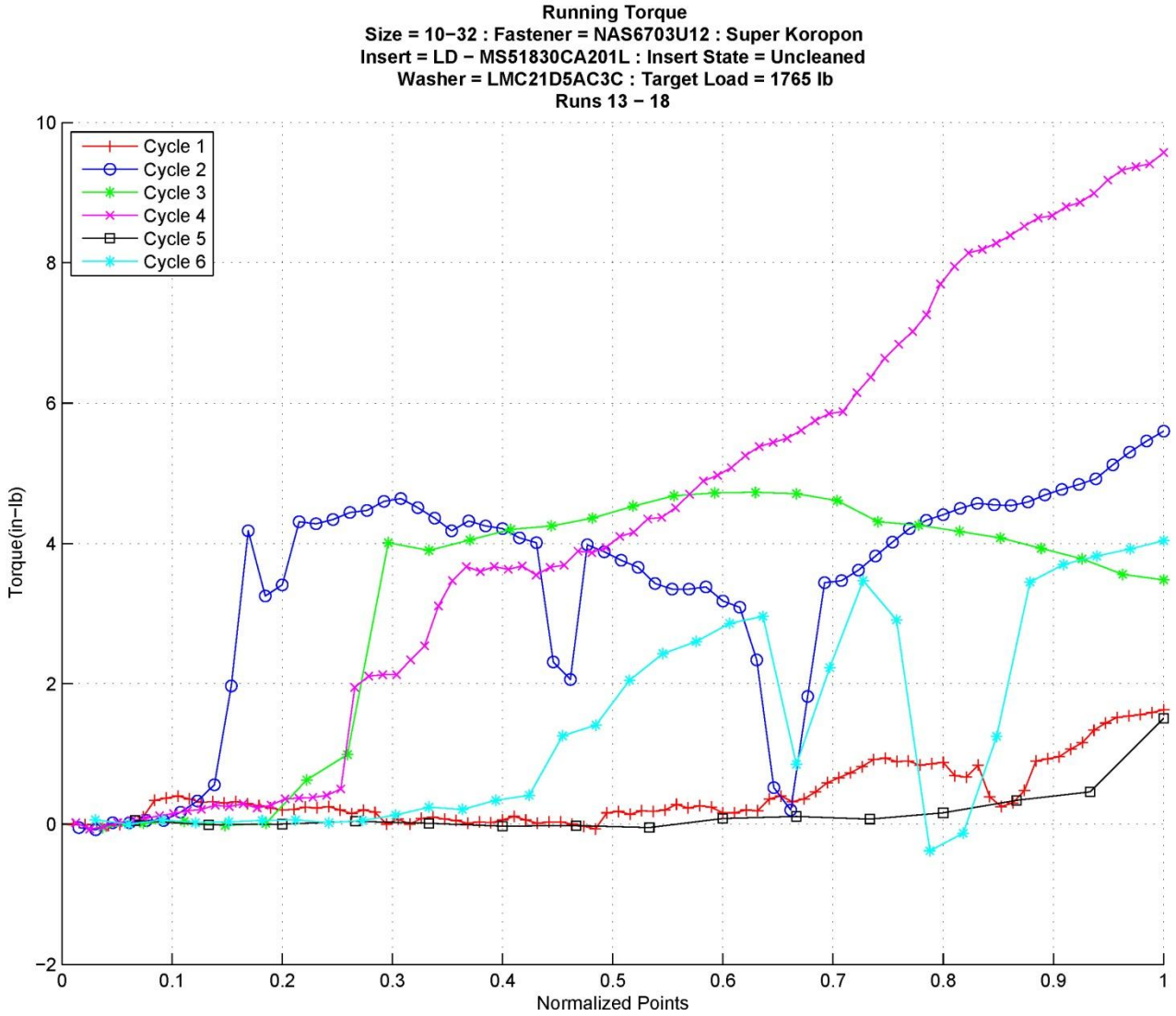

Running Torque
Size = 10−32 : Fastener = NAS6703U12 : No Lube
Insert = ExHD − MS51832CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 77 − 82
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
16
14
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

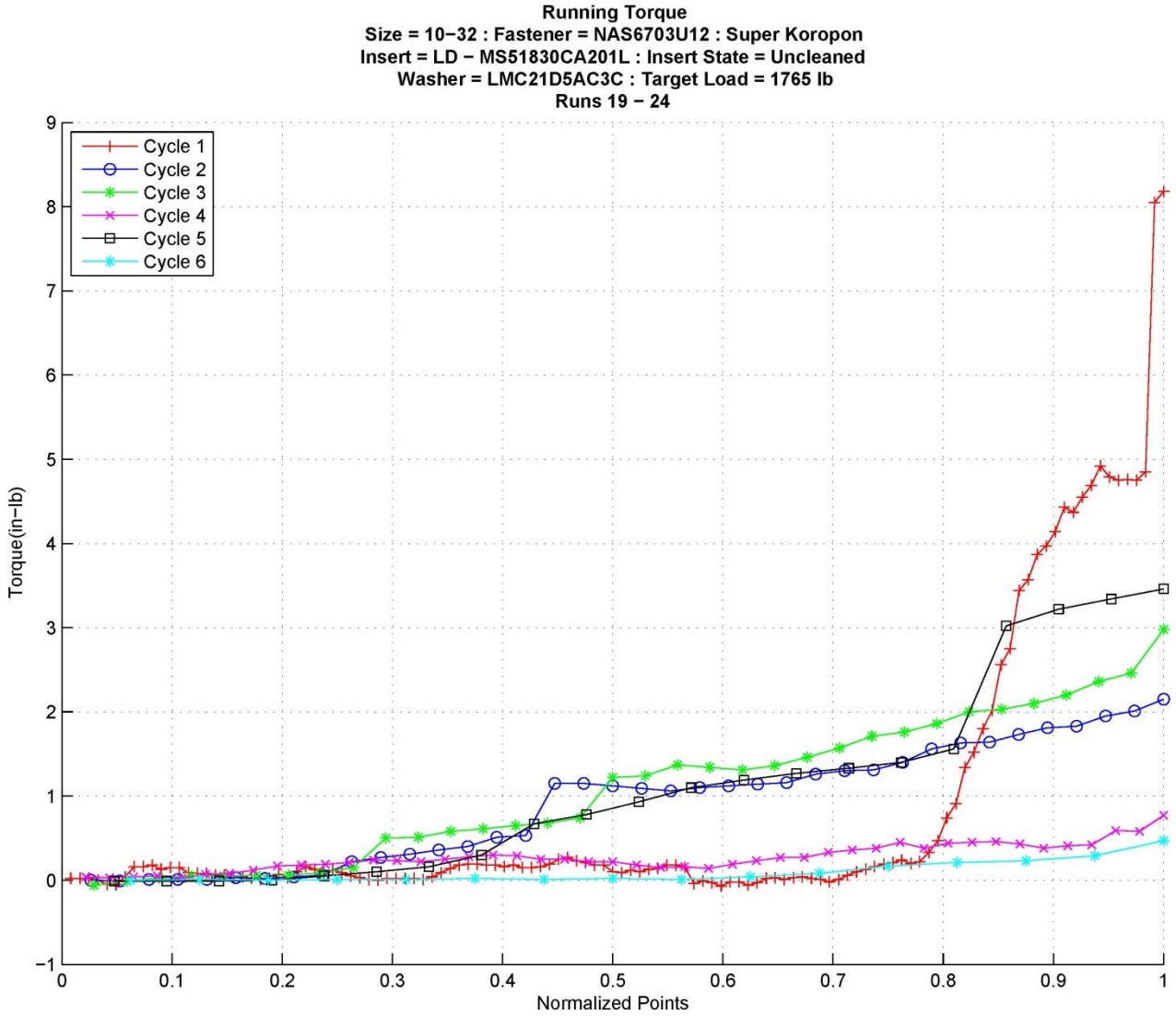
Appendix A:

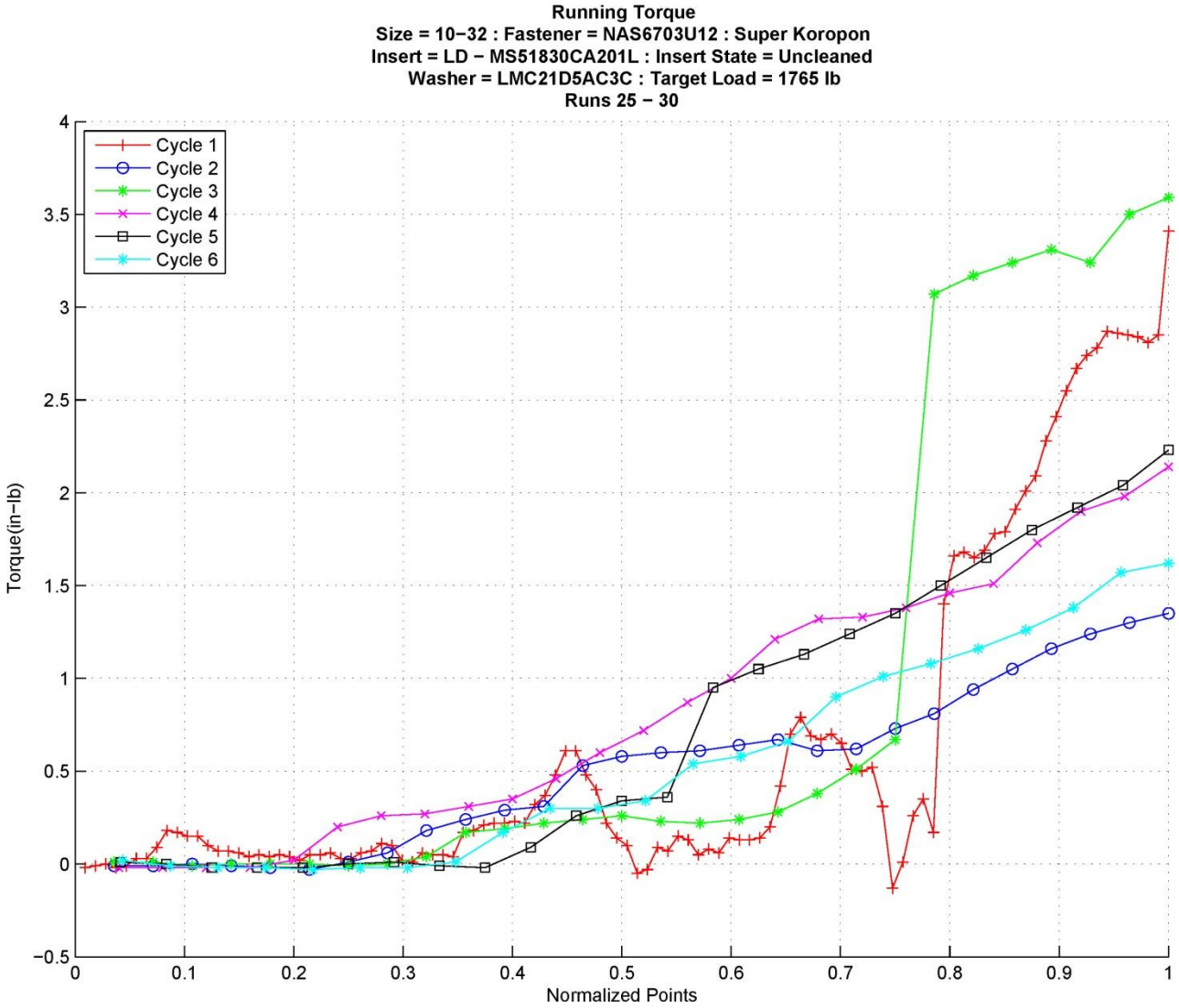
Section 1	10-32 Dry Torque Tension Plots
Section 2	10-32 Wet Torque Tension Plots
Section 3	10-32 Dry Running Torque Plots
Section 4	10-32 Wet Running Torque Plots
Section 5	10-32 Dry Cycle Plots: Torque vs. Load
Section 6	10-32 Wet Cycle Plots: Torque vs. Load
Section 7	10-32 Friction Coefficients
Section 8	10-32 Test Plate Layouts
Section 9	10-32 Dry Run Logs
Section 10	10-32 Wet Run Logs

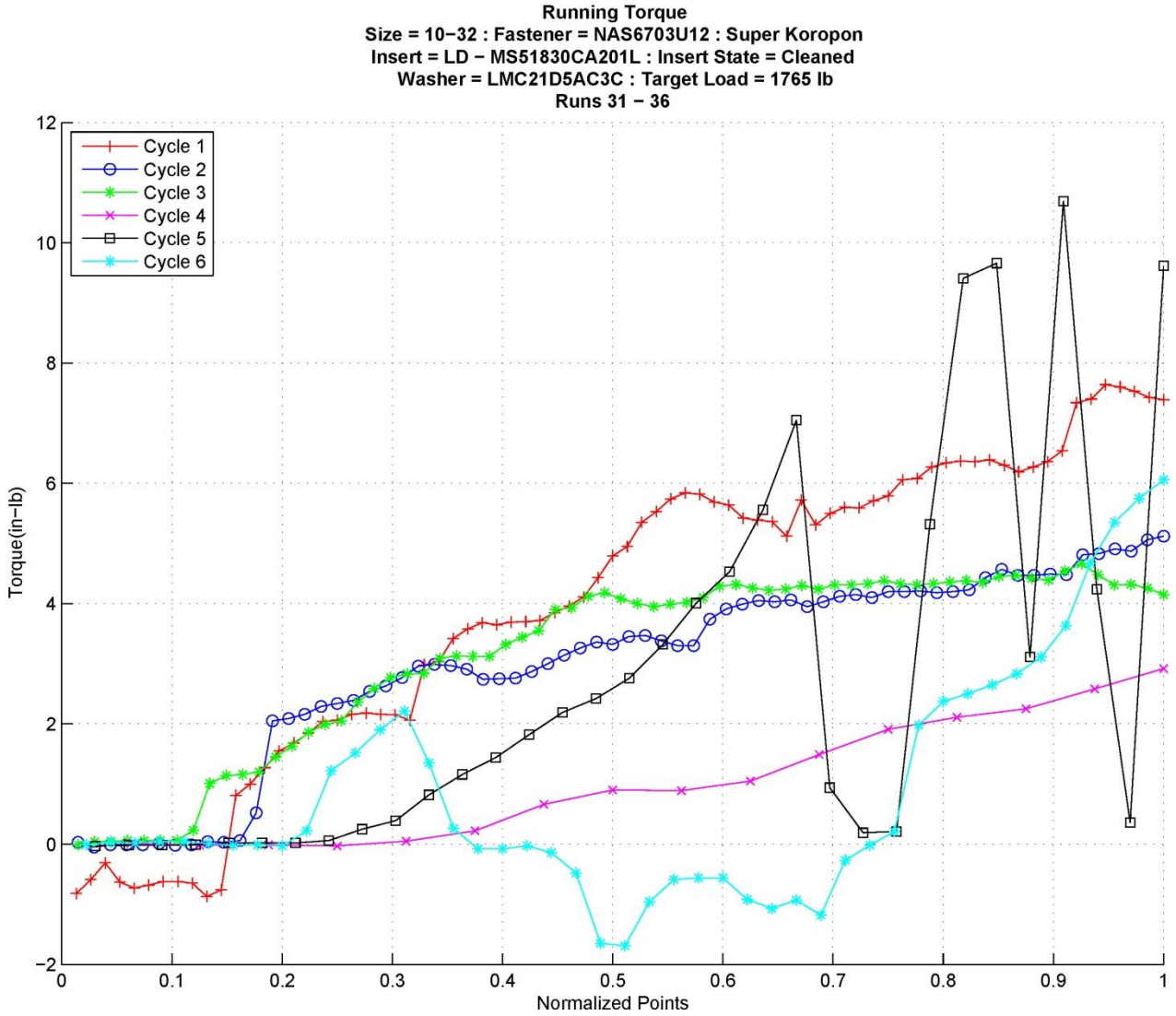

Running Torque
Size = 10−32 : Fastener = NAS6703U12 : Super Koropon
Insert = LD − MS51830CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 1 − 6
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

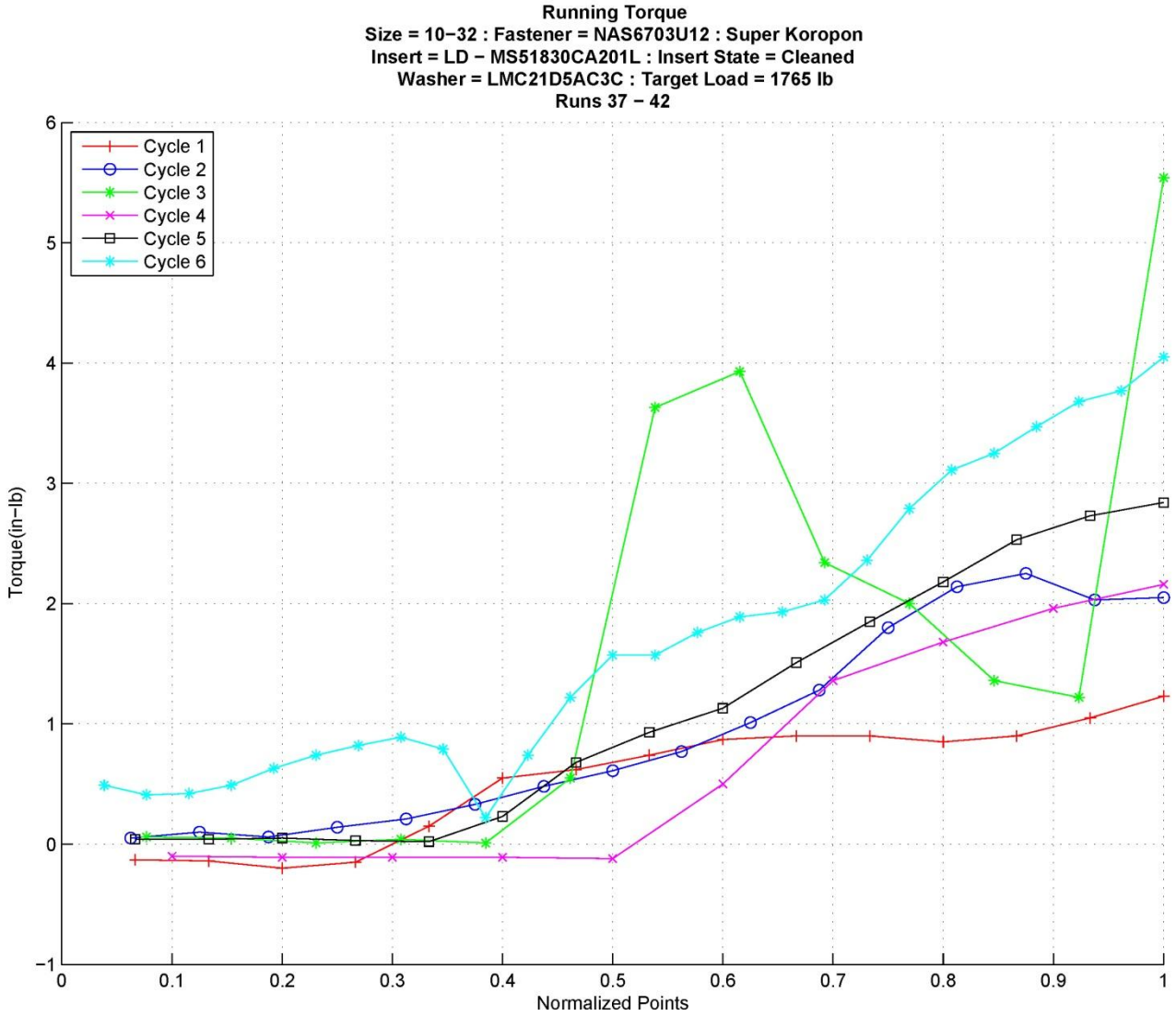

Running Torque
Size = 10−32 : Fastener = NAS6703U12 : Super Koropon
Insert = LD − MS51830CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 7 − 12
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

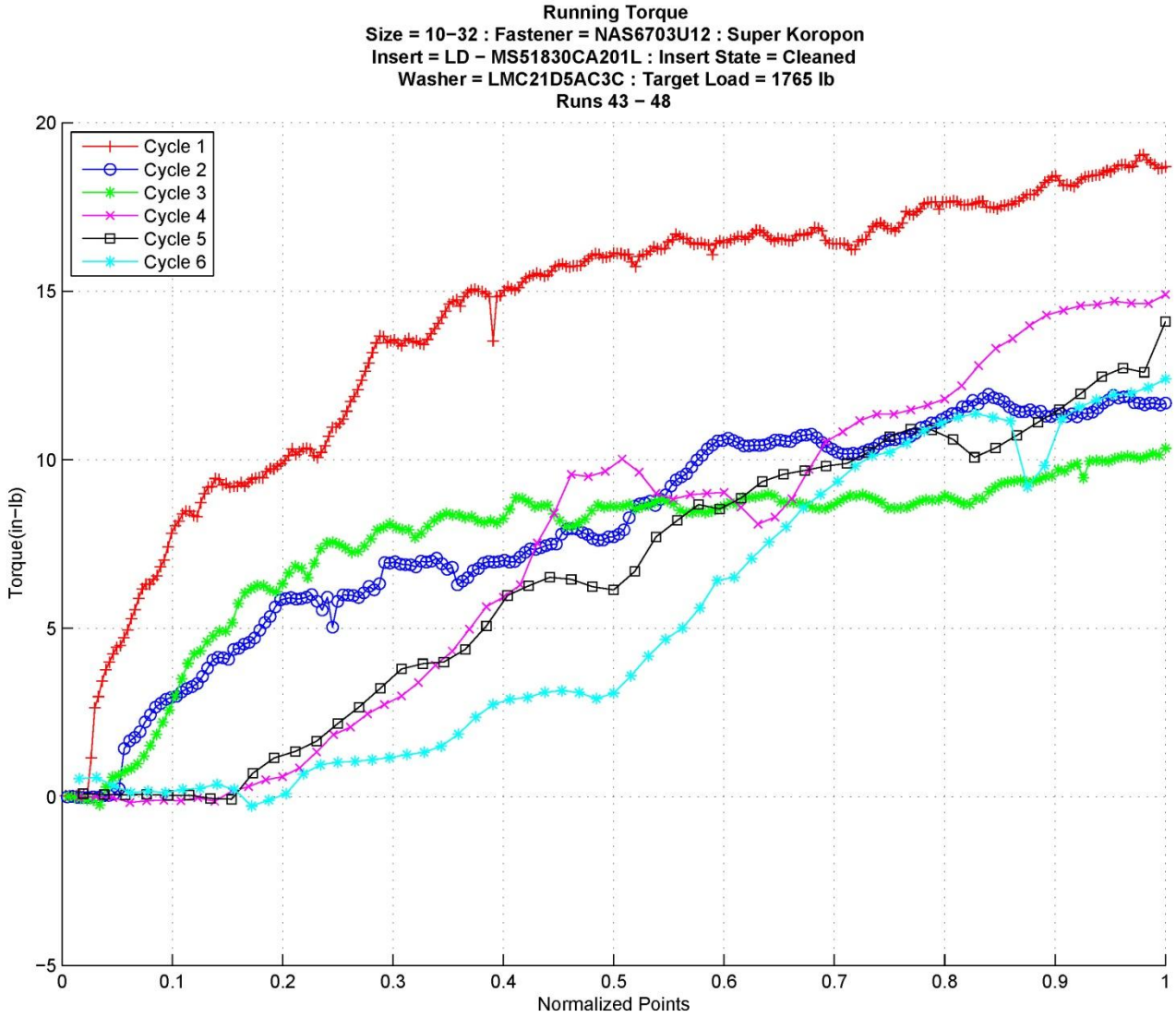

Running Torque
Size = 10−32 : Fastener = NAS6703U12 : Super Koropon
Insert = LD − MS51830CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 13 − 18
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

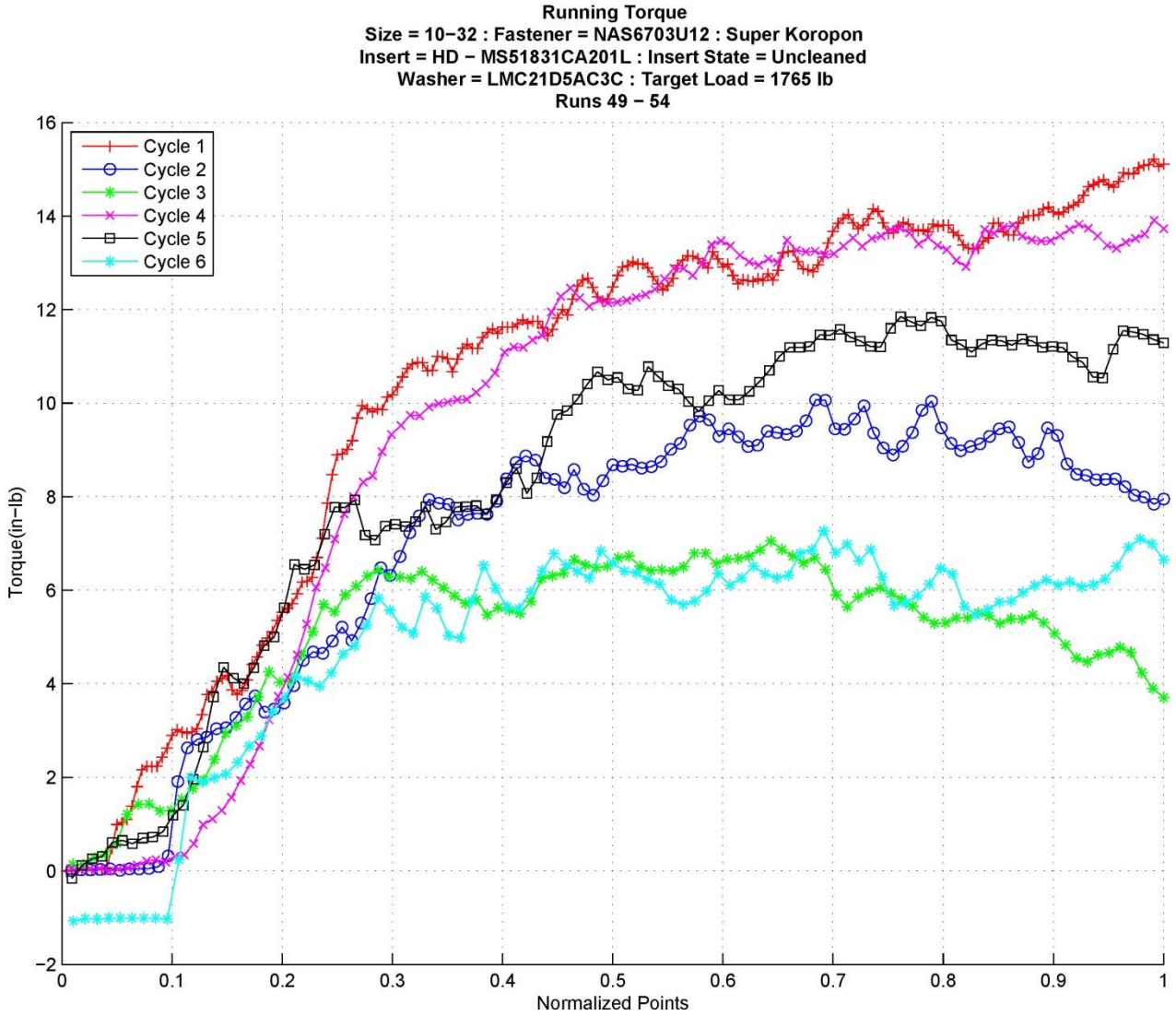

Running Torque
Size = 10−32 : Fastener = NAS6703U12 : Super Koropon
Insert = LD − MS51830CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 19 − 24
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
9
8
7
6
5
4
3
2
1
0
−1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

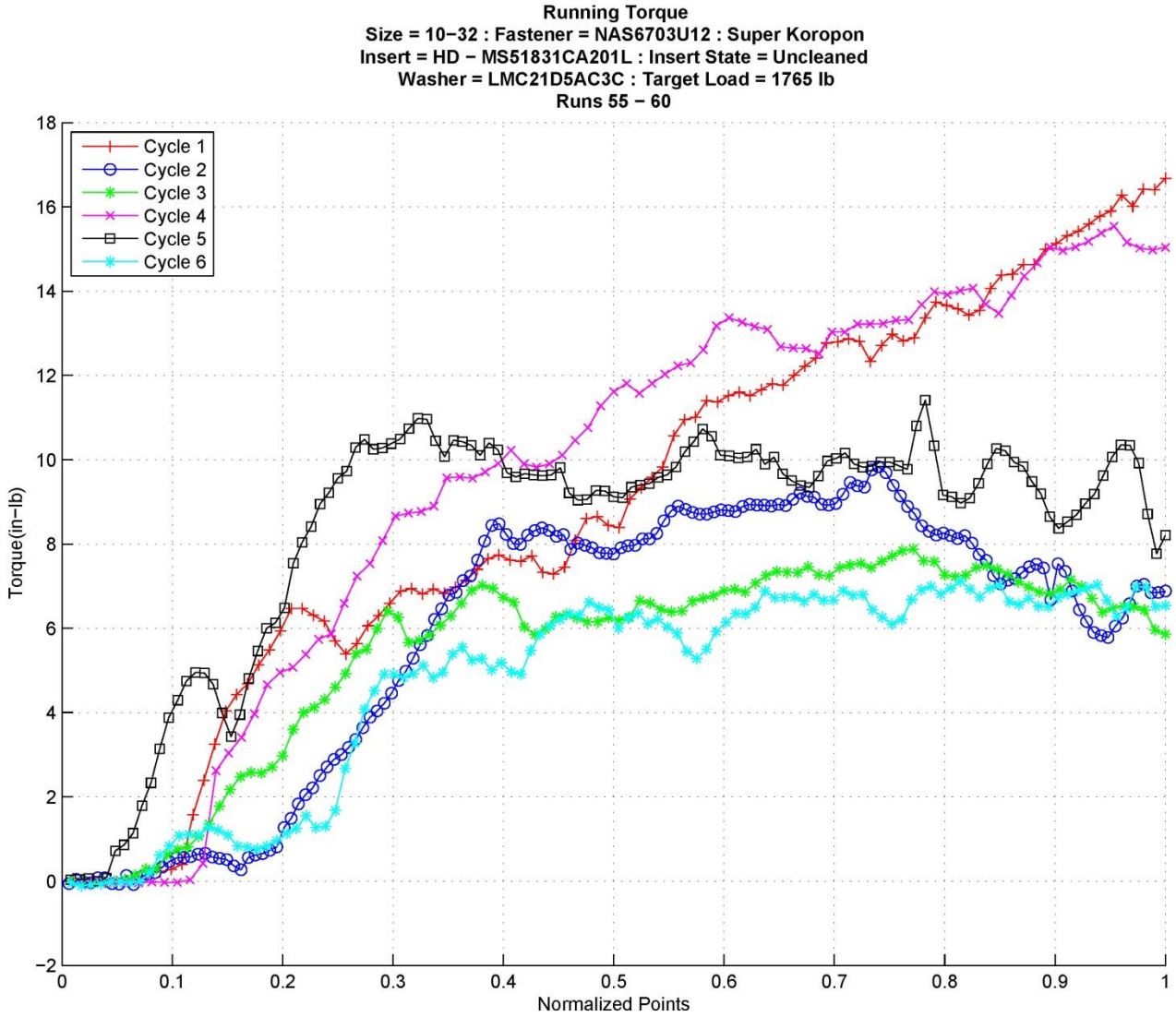

Running Torque
Size = 10−32 : Fastener = NAS6703U12 : Super Koropon
Insert = LD − MS51830CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 25 − 30
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
4
3.5
3
2.5
2
1.5
1
0.5
0
−0.5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

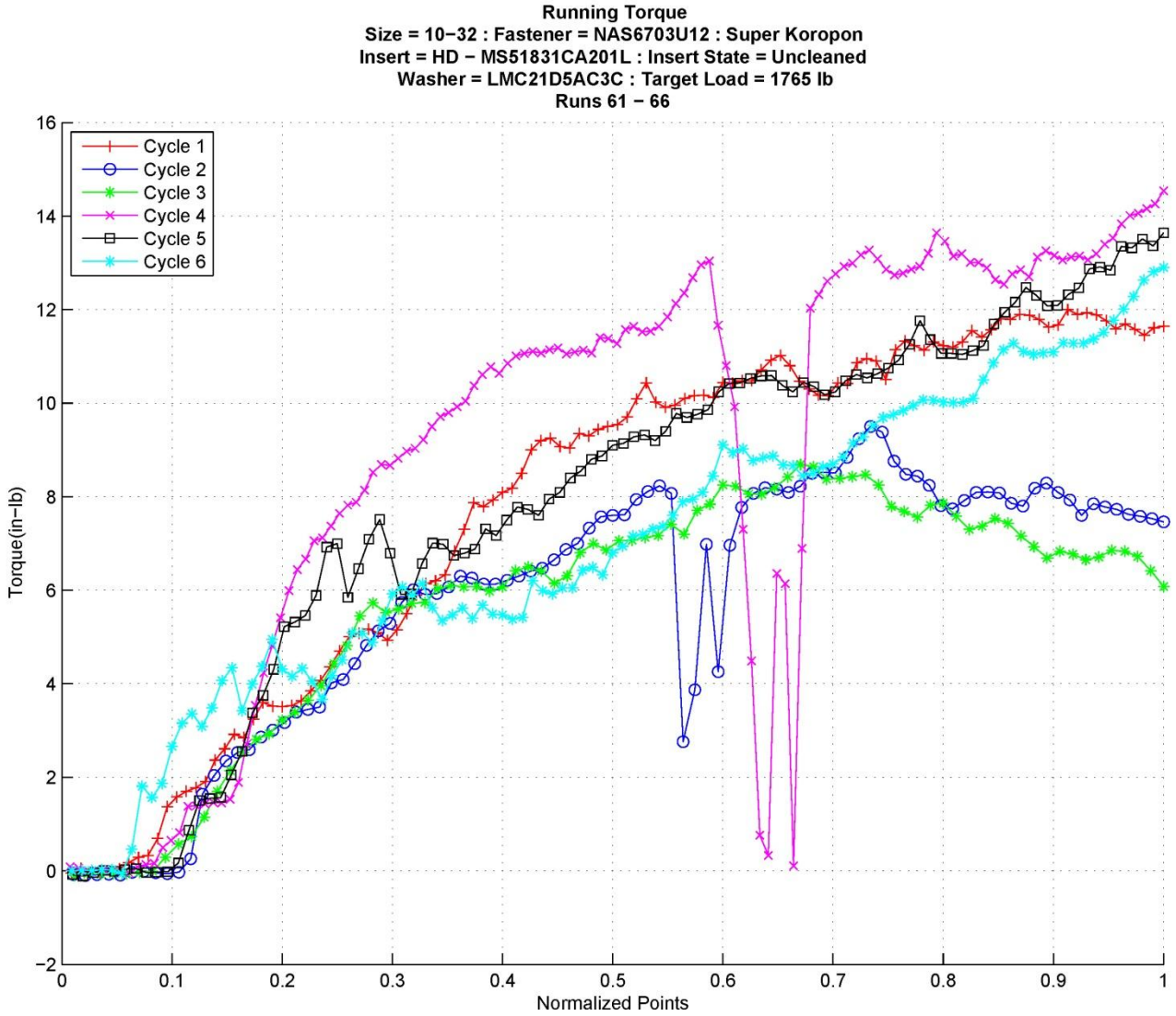

Running Torque
Size = 10−32 : Fastener = NAS6703U12 : Super Koropon
Insert = LD − MS51830CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 31 − 36
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

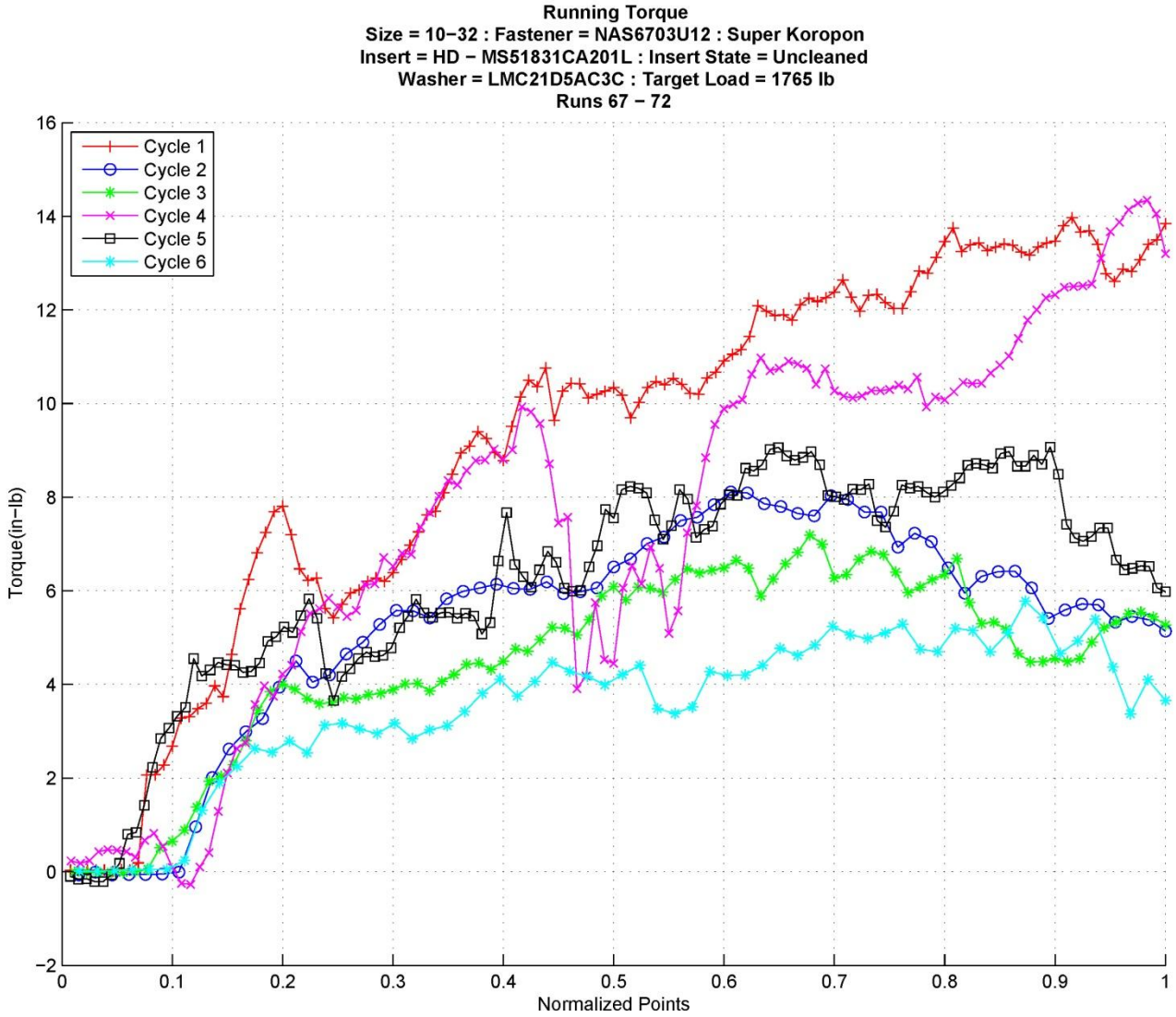

Running Torque
Size = 10−32 : Fastener = NAS6703U12 : Super Koropon
Insert = LD − MS51830CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 37 − 42
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
6
5
4
3
2
1
0
−1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

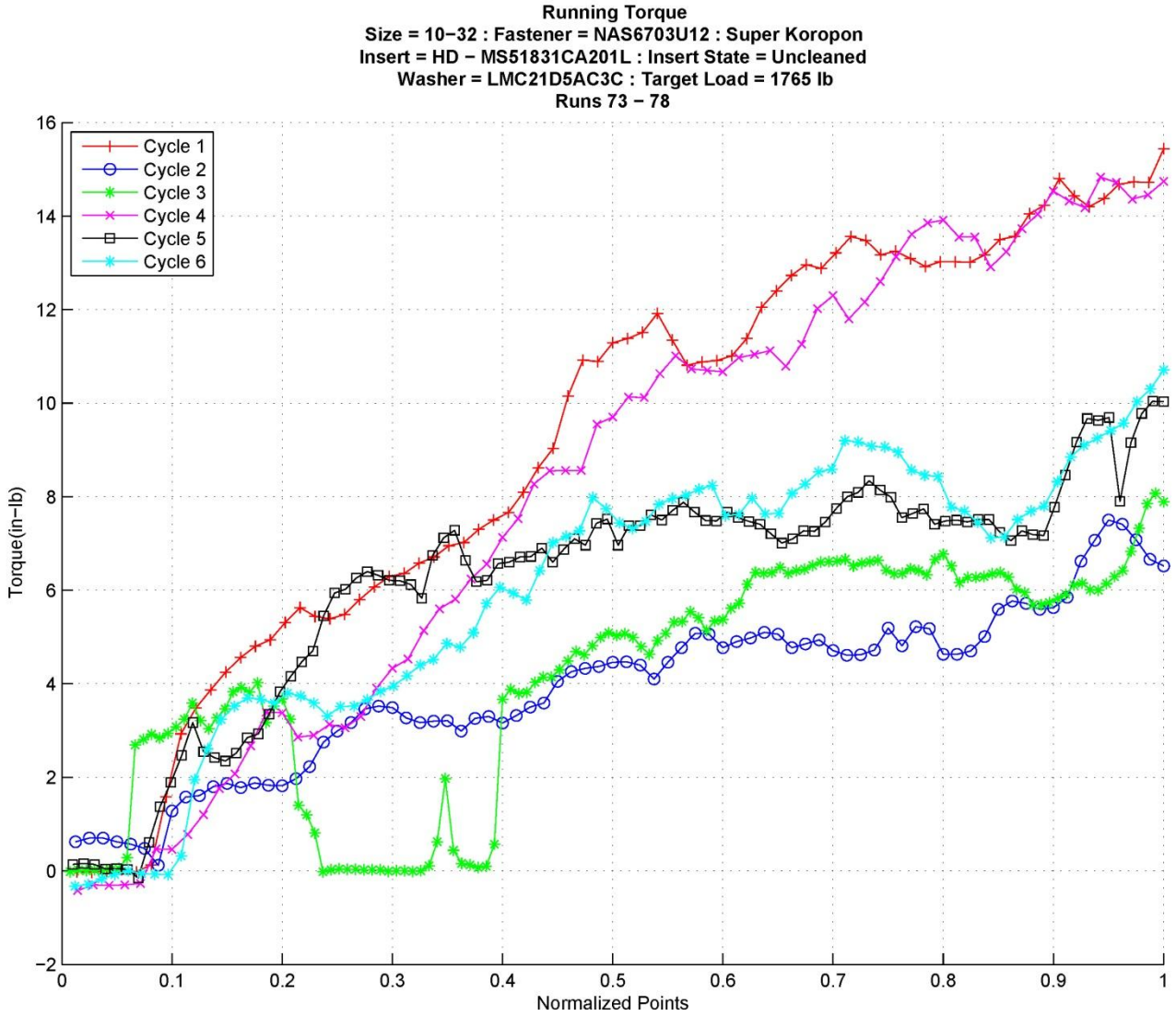

Running Torque
Size = 10−32 : Fastener = NAS6703U12 : Super Koropon
Insert = LD − MS51830CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 43 − 48
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
20
15
10
5
0
−5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

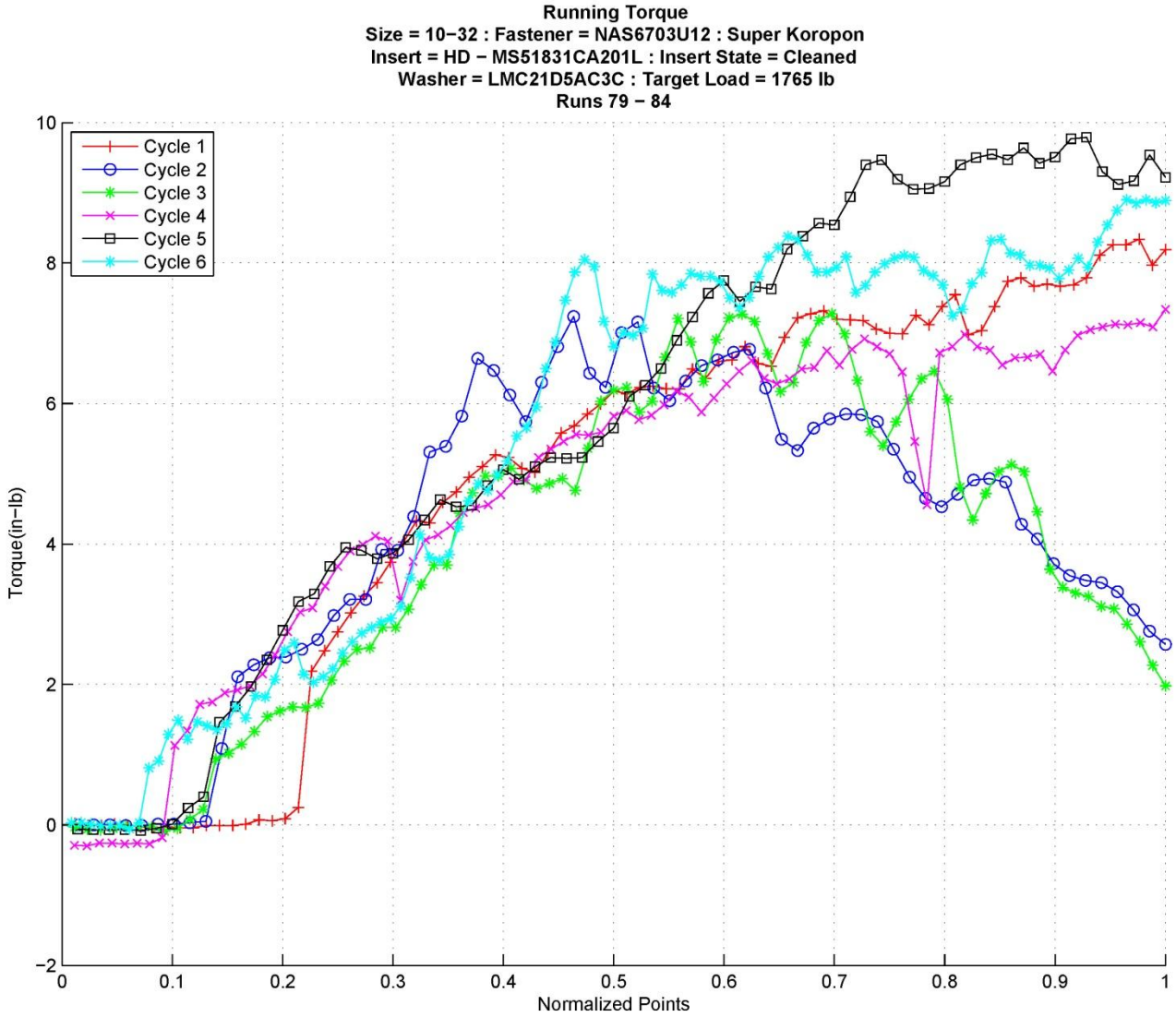

Running Torque
Size = 10−32 : Fastener = NAS6703U12 : Super Koropon
Insert = HD − MS51831CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 49 − 54
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
16
14
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

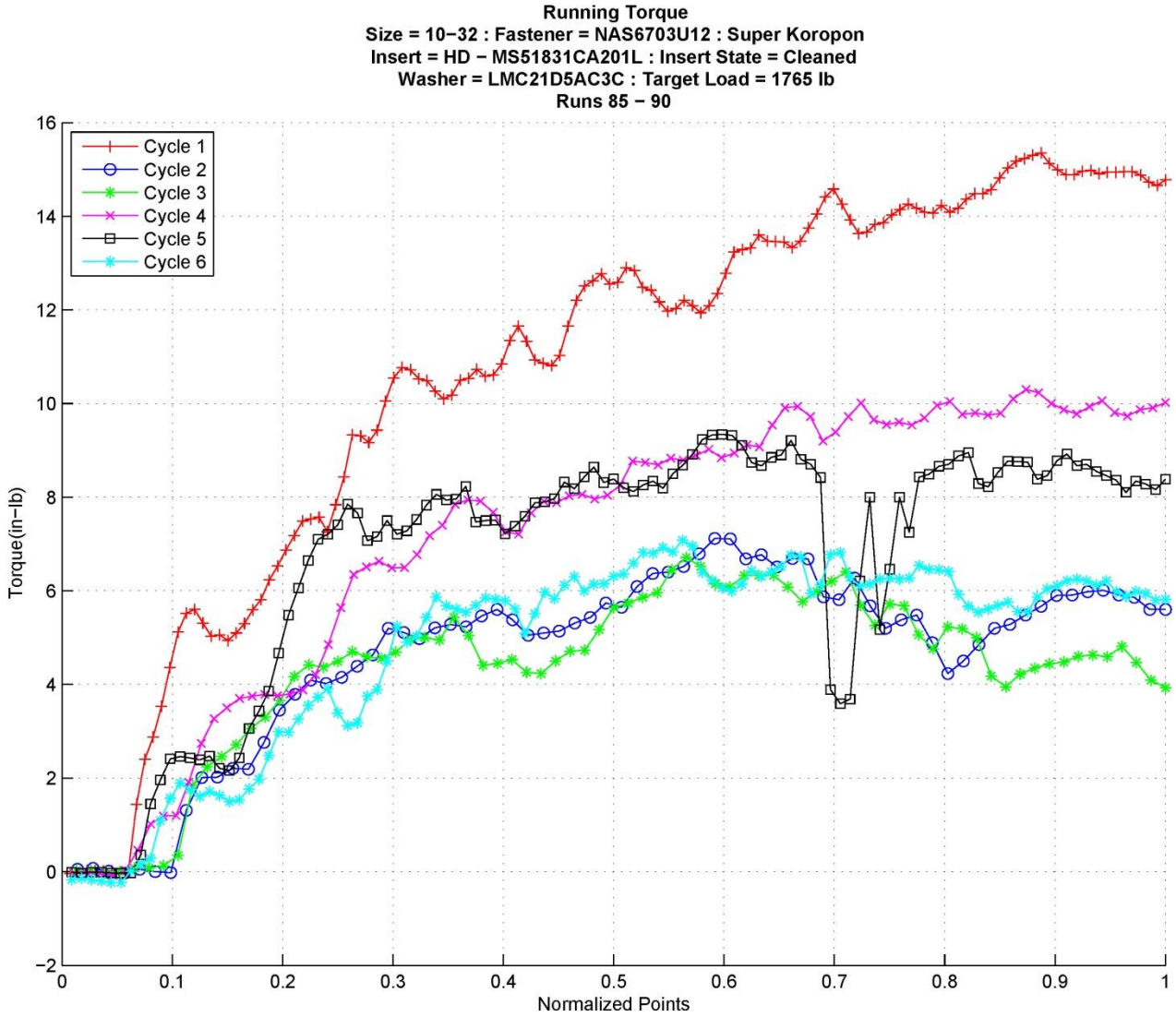

Running Torque
Size = 10−32 : Fastener = NAS6703U12 : Super Koropon
Insert = HD − MS51831CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 55 − 60
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
18
16
14
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

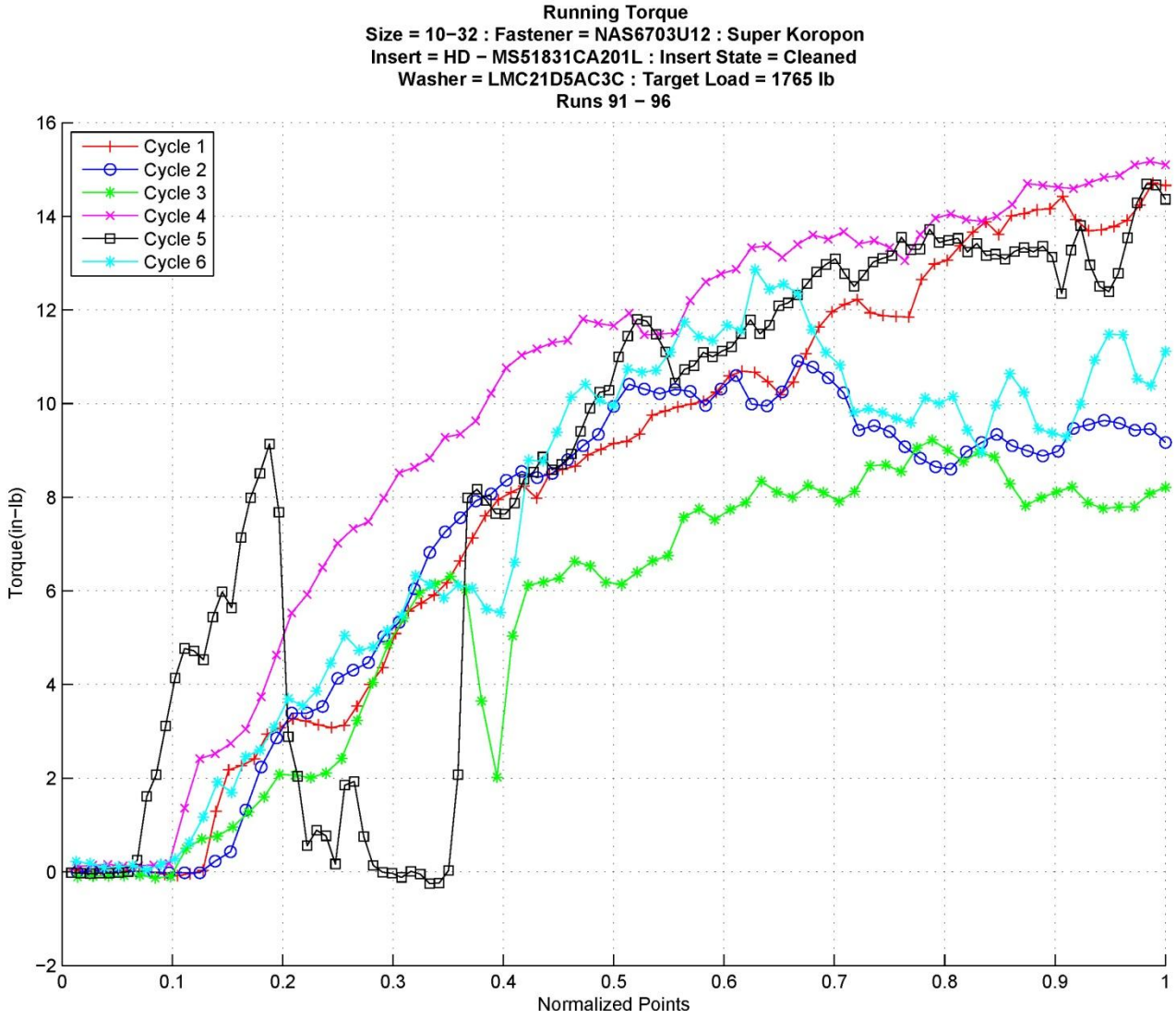

Running Torque
Size = 10−32 : Fastener = NAS6703U12 : Super Koropon
Insert = HD − MS51831CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 61 − 66
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
16
14
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

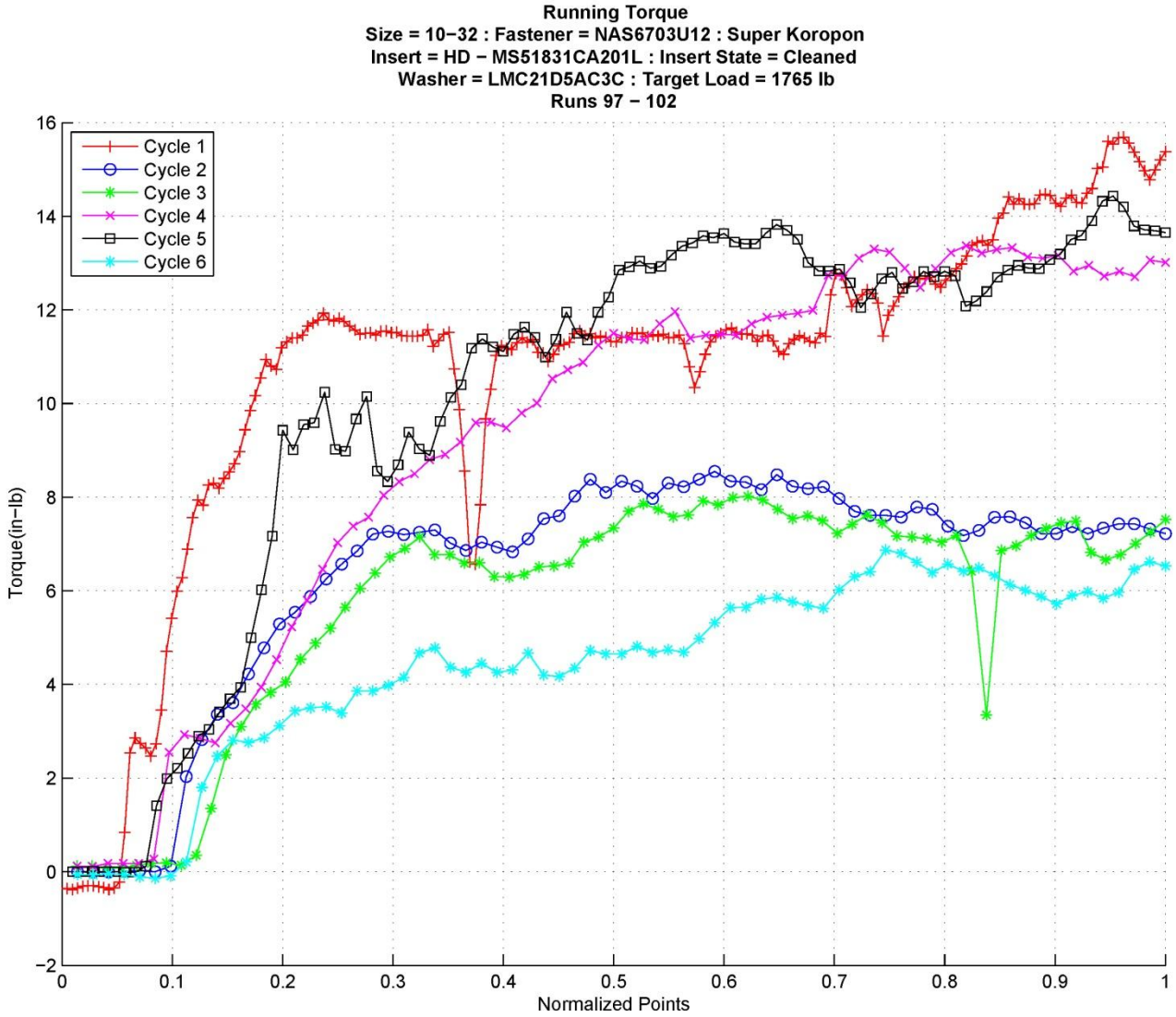

Running Torque
Size = 10−32 : Fastener = NAS6703U12 : Super Koropon
Insert = HD − MS51831CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 67 − 72
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
16
14
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

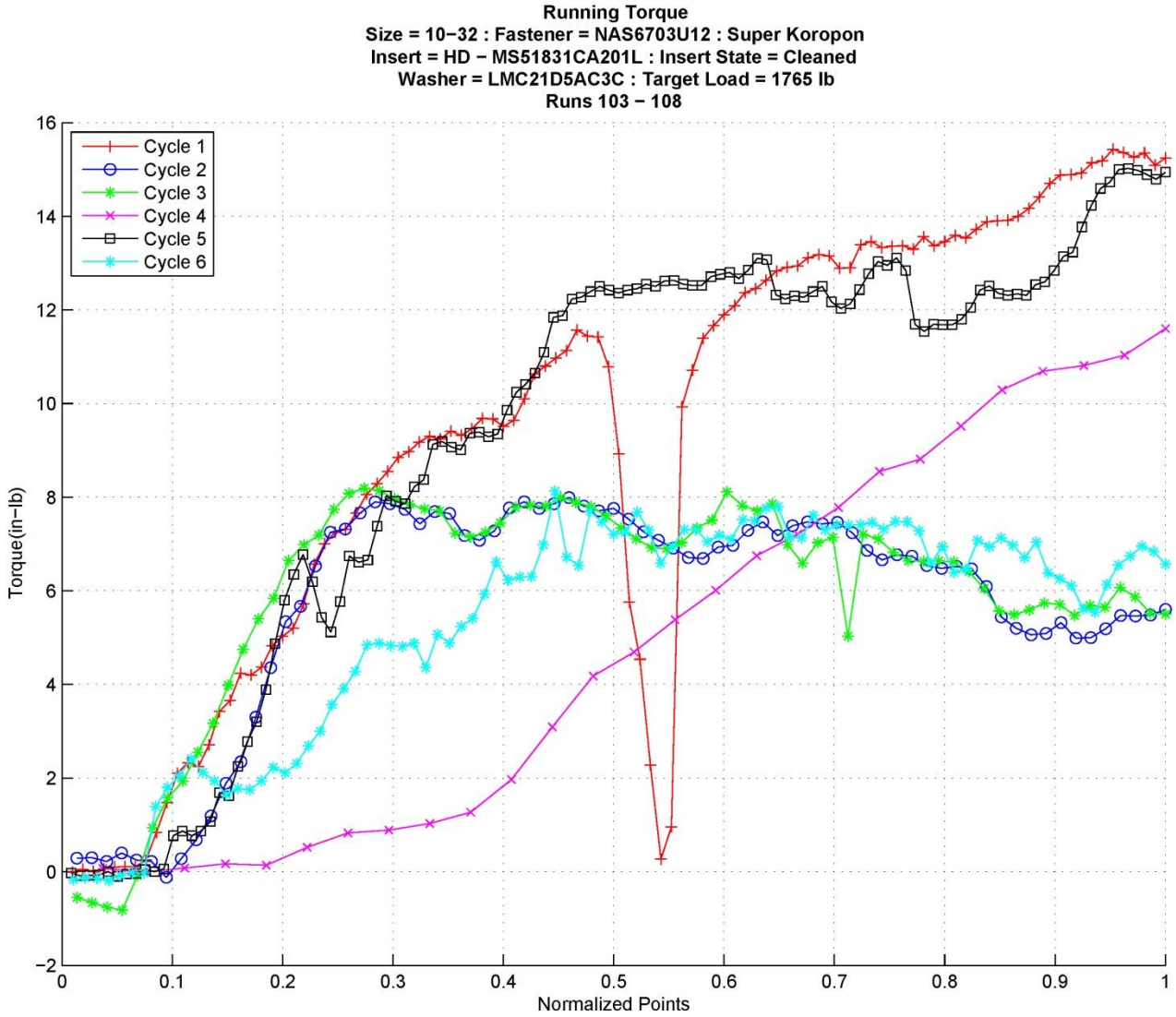

Running Torque
Size = 10−32 : Fastener = NAS6703U12 : Super Koropon
Insert = HD − MS51831CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 73 − 78
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
16
14
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


Running Torque
Size = 10−32 : Fastener = NAS6703U12 : Super Koropon
Insert = HD − MS51831CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 79 − 84
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


Running Torque
Size = 10−32 : Fastener = NAS6703U12 : Super Koropon
Insert = HD − MS51831CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 85 − 90
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
16
14
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

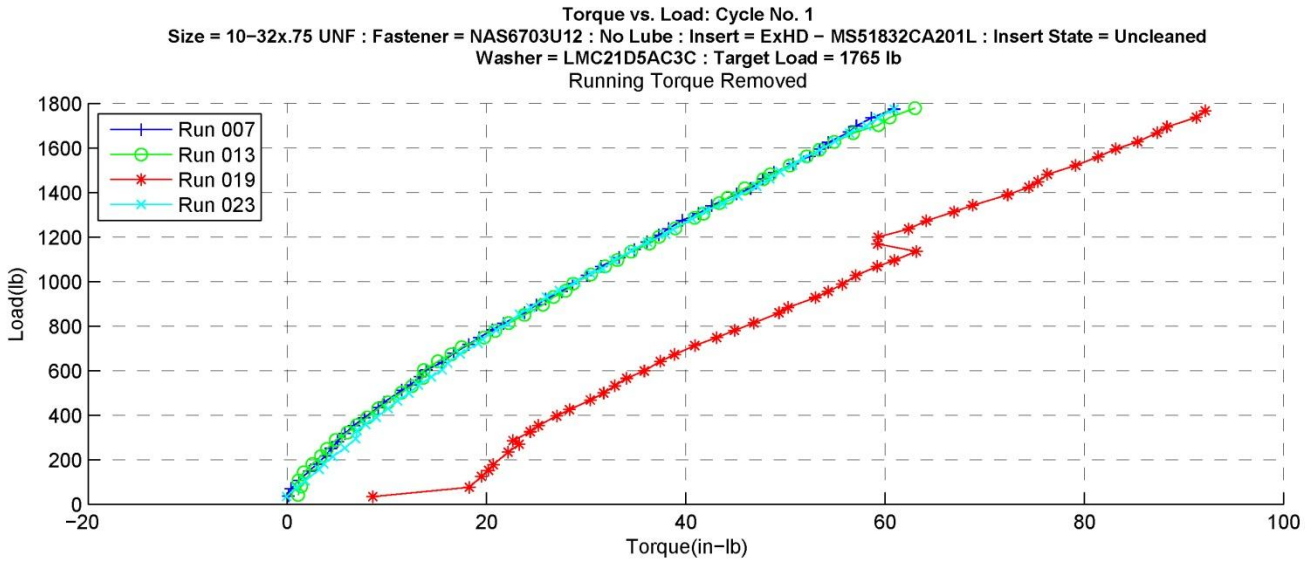

Running Torque
Size = 10−32 : Fastener = NAS6703U12 : Super Koropon
Insert = HD − MS51831CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 91 − 96
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
16
14
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

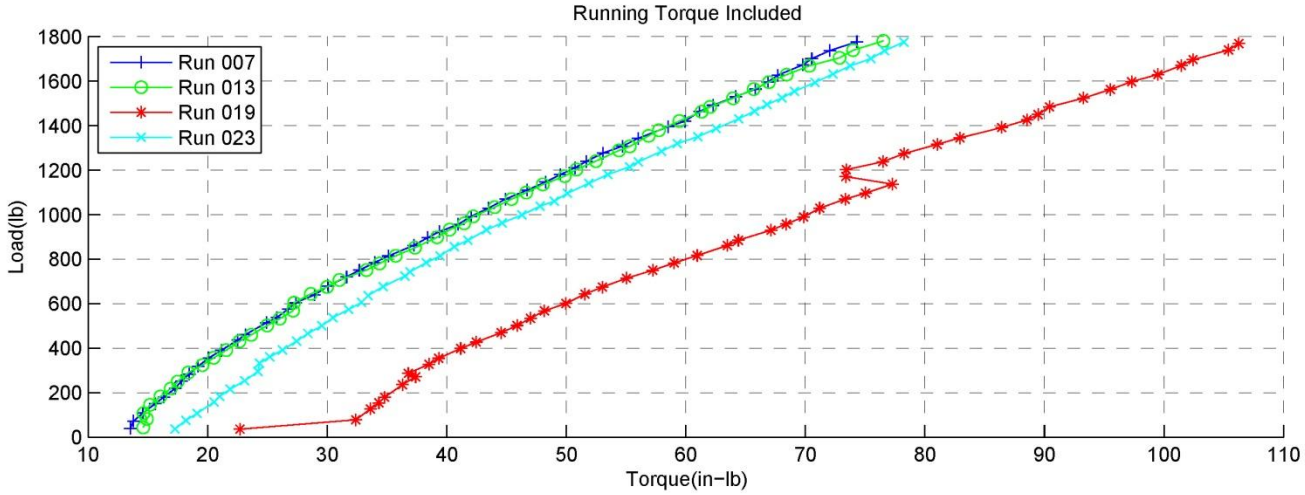

Running Torque
Size = 10−32 : Fastener = NAS6703U12 : Super Koropon
Insert = HD − MS51831CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 97 − 102
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
16
14
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

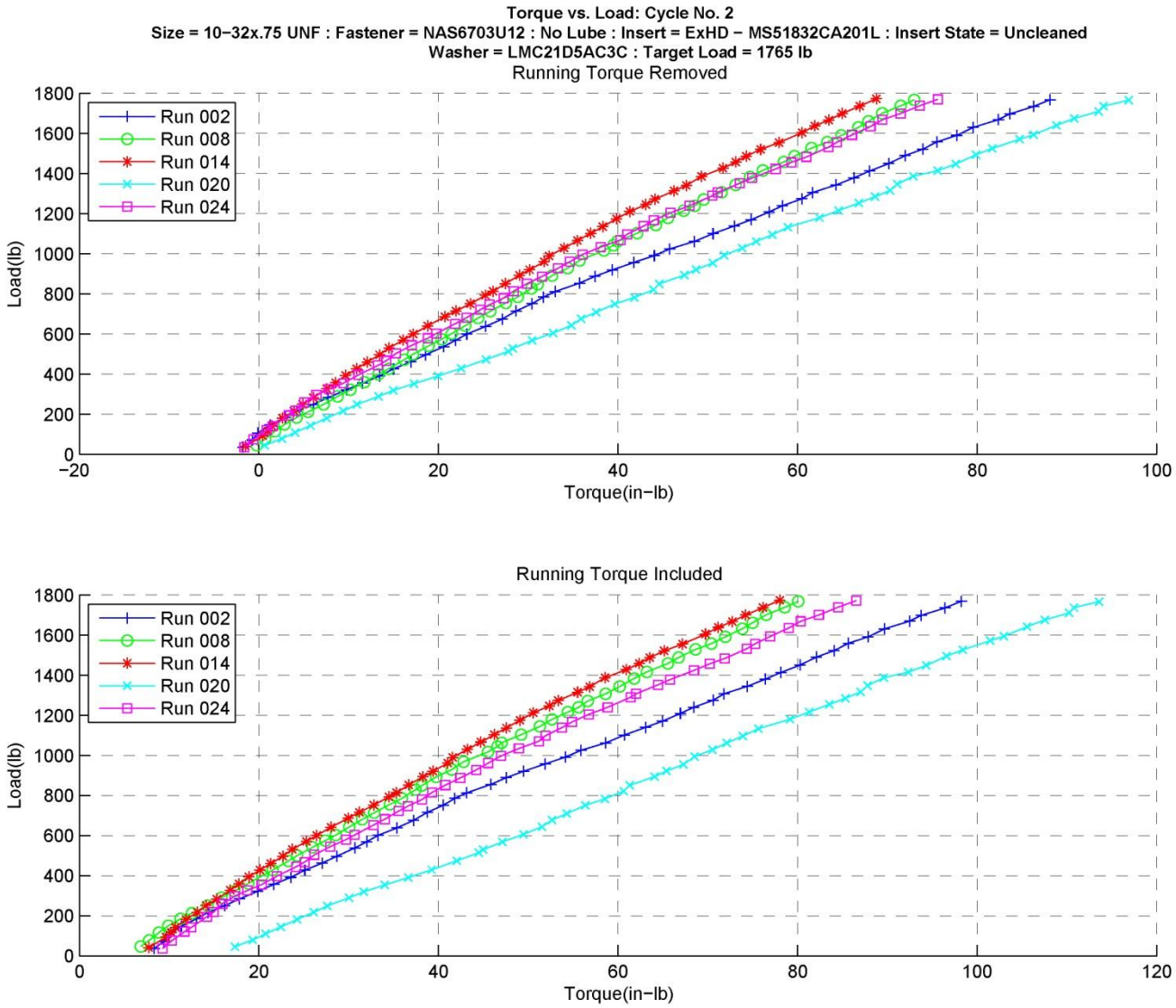

Running Torque
Size = 10−32 : Fastener = NAS6703U12 : Super Koropon
Insert = HD − MS51831CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Runs 103 − 108
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
16
14
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

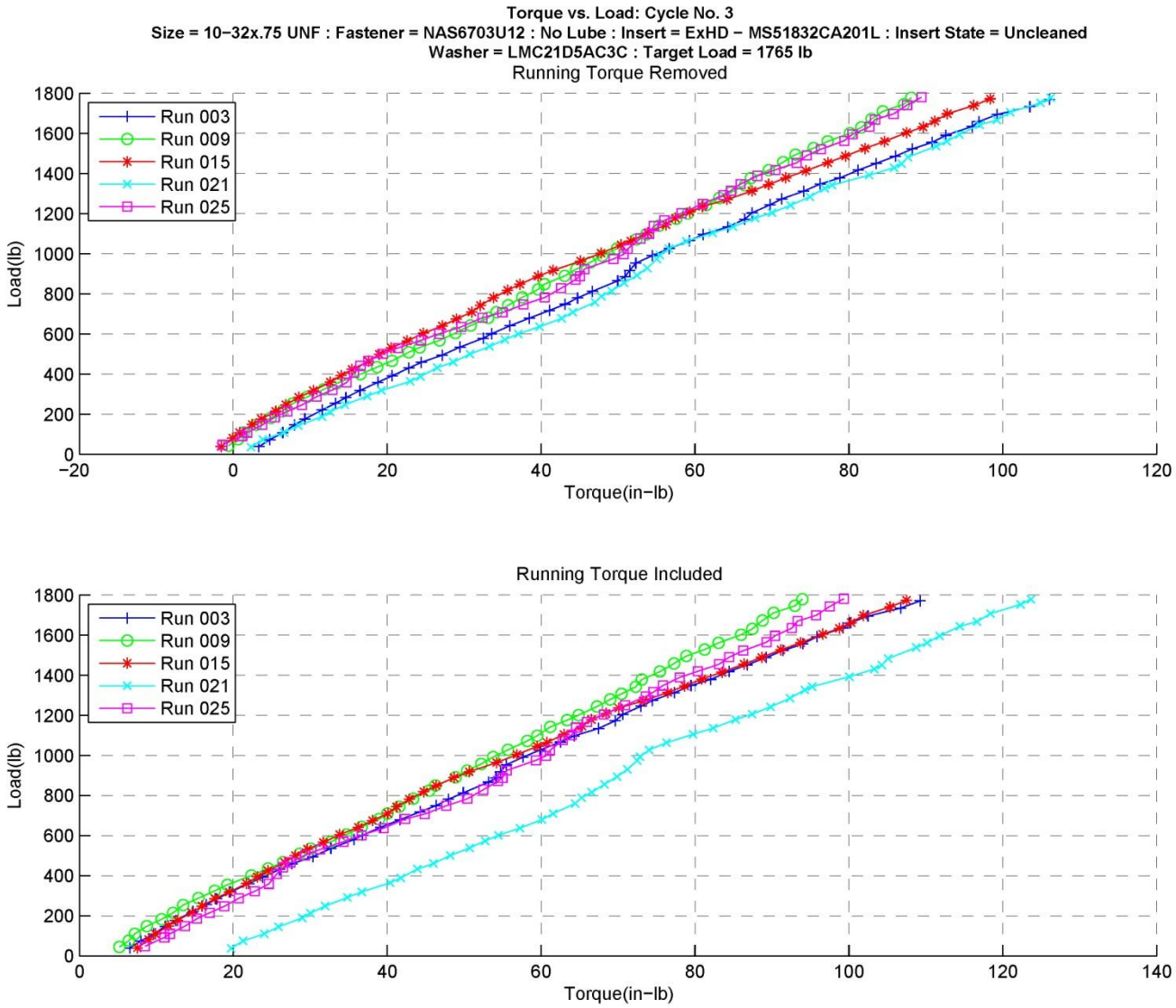
Appendix A:

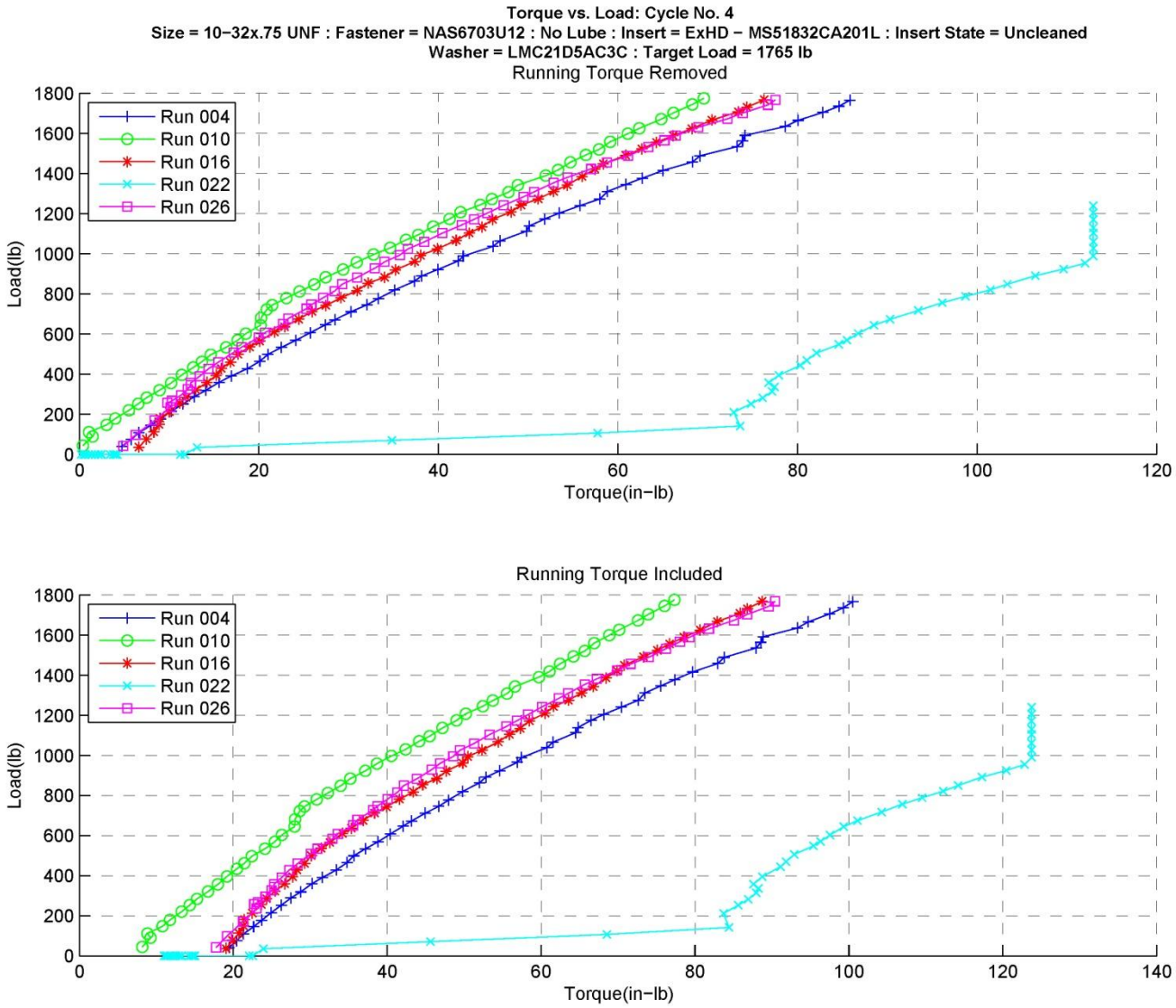
Section 1	10-32 Dry Torque Tension Plots
Section 2	10-32 Wet Torque Tension Plots
Section 3	10-32 Dry Running Torque Plots
Section 4	10-32 Wet Running Torque Plots
Section 5	10-32 Dry Cycle Plots: Torque vs. Load
Section 6	10-32 Wet Cycle Plots: Torque vs. Load
Section 7	10-32 Friction Coefficients
Section 8	10-32 Test Plate Layouts
Section 9	10-32 Dry Run Logs
Section 10	10-32 Wet Run Logs

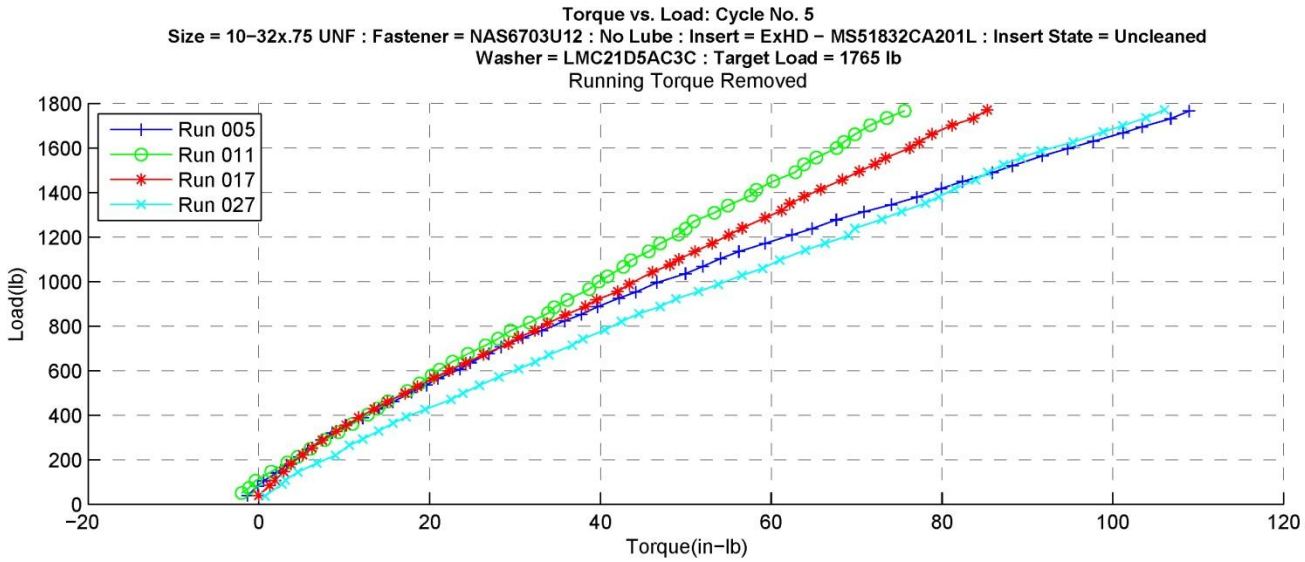

Torque vs. Load: Cycle No. 1
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : No Lube : Insert = ExHD − MS51832CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 007
Run 013
Run 019
Run 023
Load(lb)
Torque(in−lb)

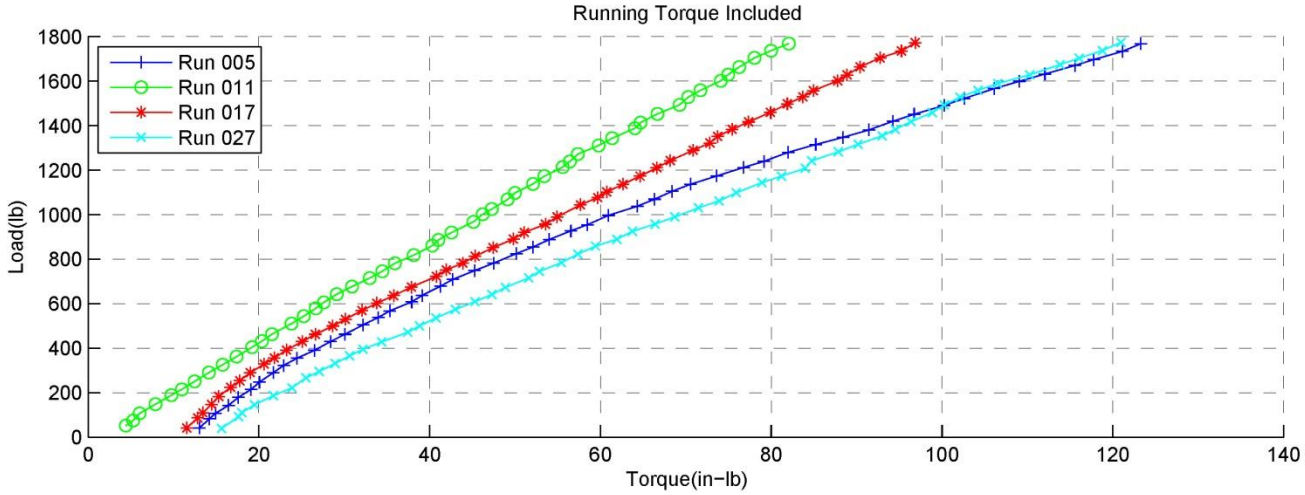

Running Torque Included
Run 007
Run 013
Run 019
Run 023
Load(lb)
Torque(in−lb)

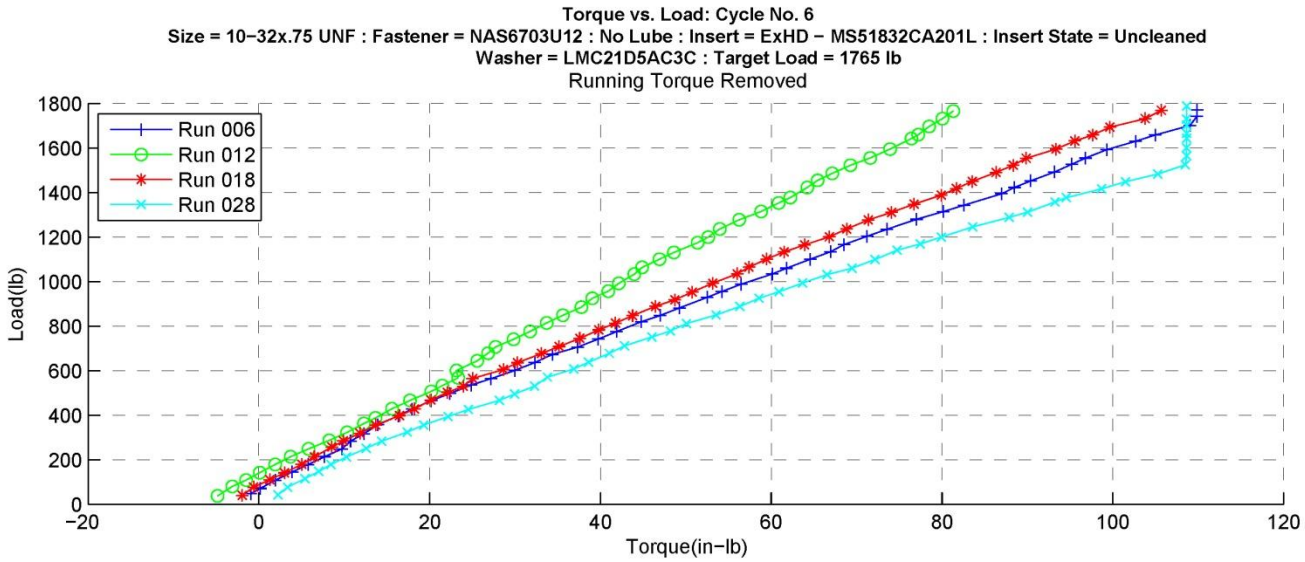

Torque vs. Load: Cycle No. 2
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : No Lube : Insert = ExHD − MS51832CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 002
Run 008
Run 014
Run 020
Run 024
Load(lb)
Torque(in−lb)
Running Torque Included
Run 002
Run 008
Run 014
Run 020
Run 024
Load(lb)
Torque(in−lb)

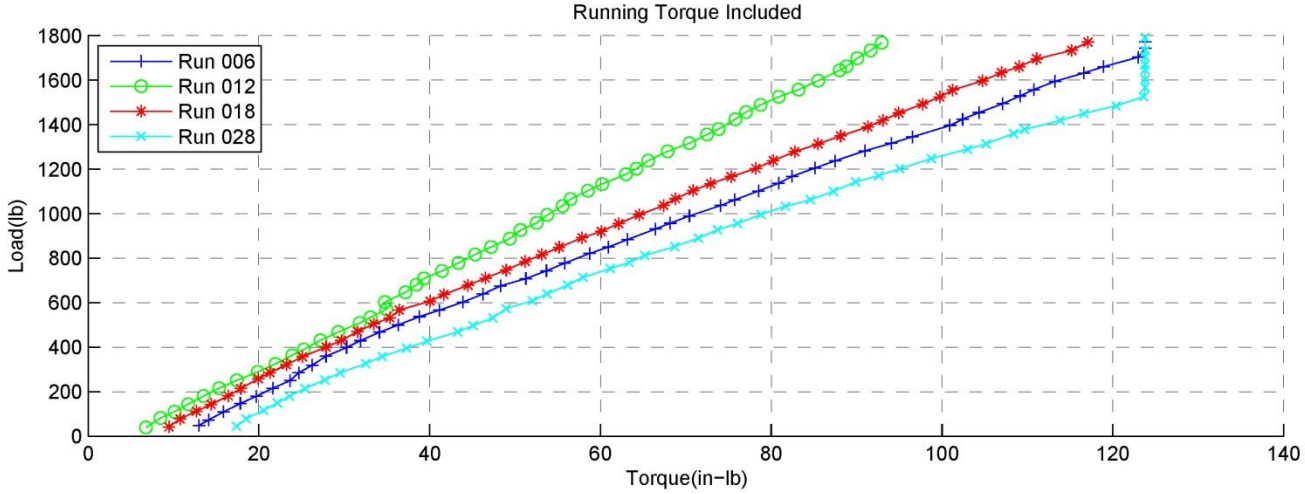

Torque vs. Load: Cycle No. 3
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : No Lube : Insert = ExHD − MS51832CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 003
Run 009
Run 015
Run 021
Run 025
Load(lb)
Torque(in−lb)
Running Torque Included
Run 003
Run 009
Run 015
Run 021
Run 025
Load(lb)
Torque(in−lb)

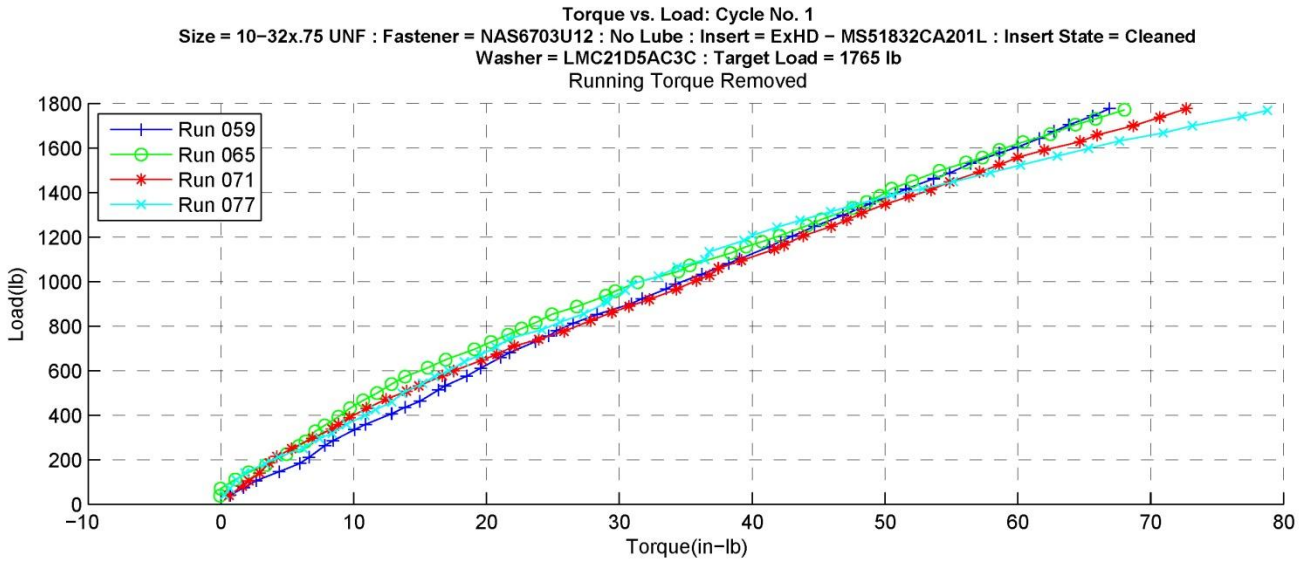

Torque vs. Load: Cycle No. 4
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : No Lube : Insert = ExHD − MS51832CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 004
Run 010
Run 016
Run 022
Run 026
Load(lb)
Torque(in−lb)
Running Torque Included
Run 004
Run 010
Run 016
Run 022
Run 026
Load(lb)
Torque(in−lb)

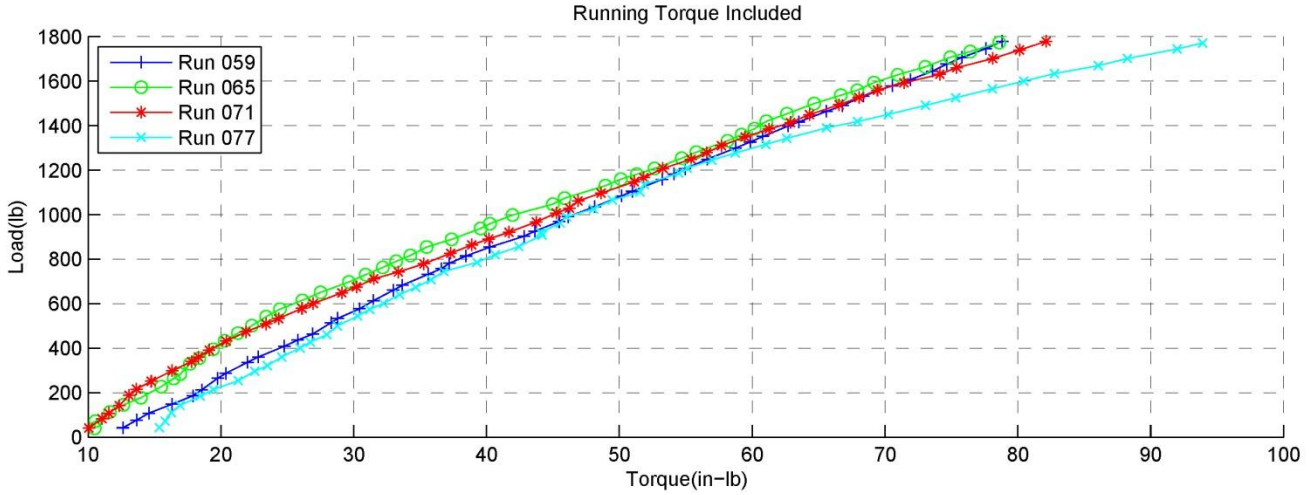

Torque vs. Load: Cycle No. 5
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : No Lube : Insert = ExHD − MS51832CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 005
Run 011
Run 017
Run 027
Load(lb)
Torque(in−lb)

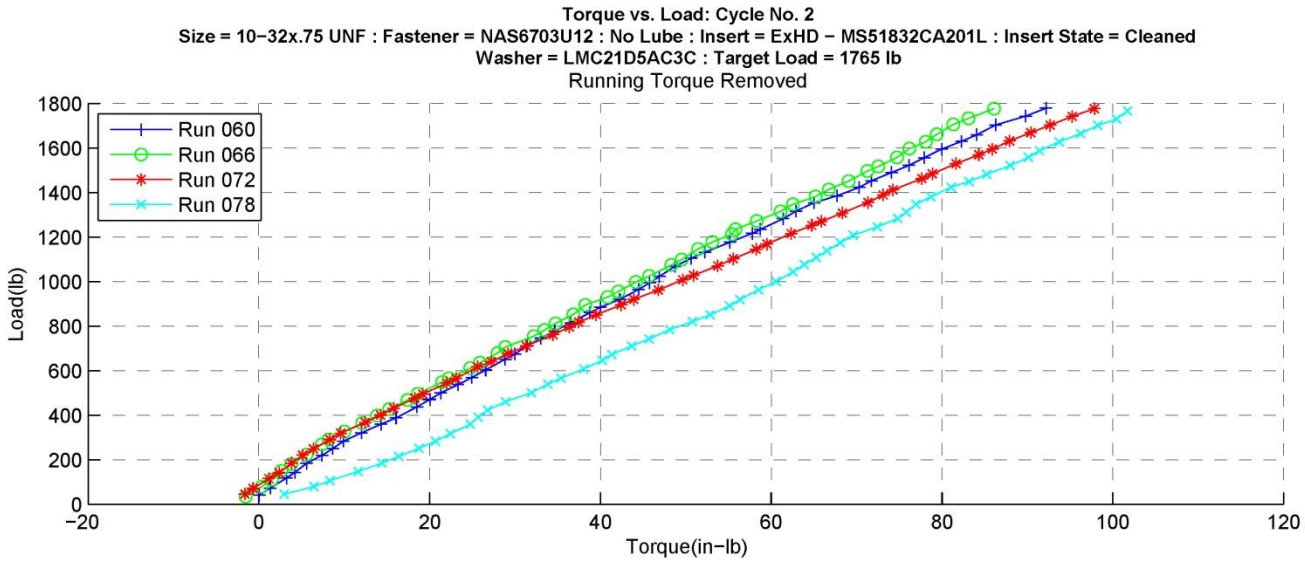

Running Torque Included
Run 005
Run 011
Run 017
Run 027
Load(lb)
Torque(in−lb)

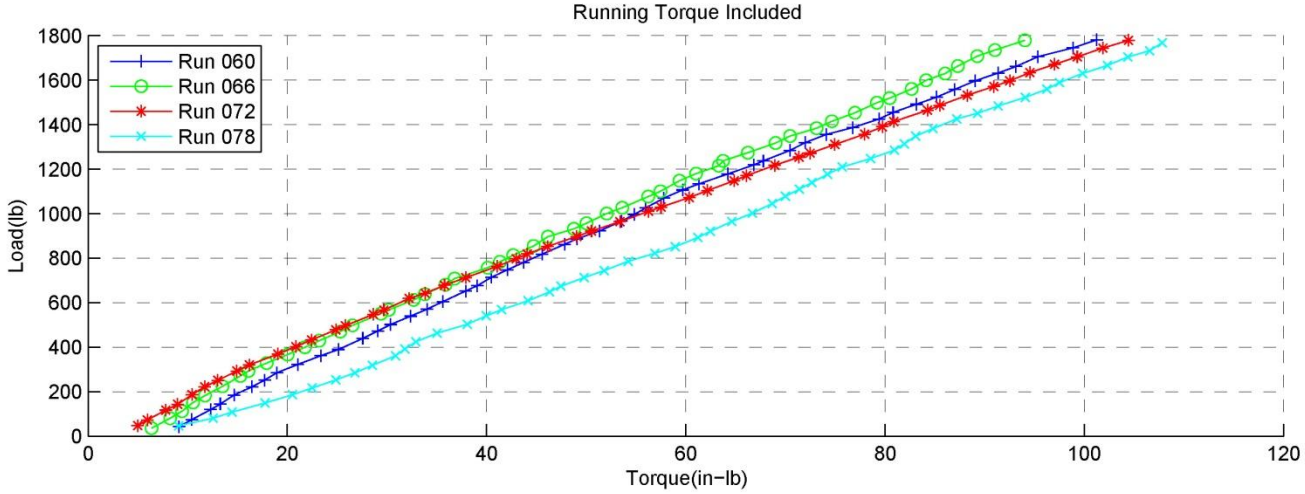

Torque vs. Load: Cycle No. 6
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : No Lube : Insert = ExHD − MS51832CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 006
Run 012
Run 018
Run 028
Load(lb)
Torque(in−lb)

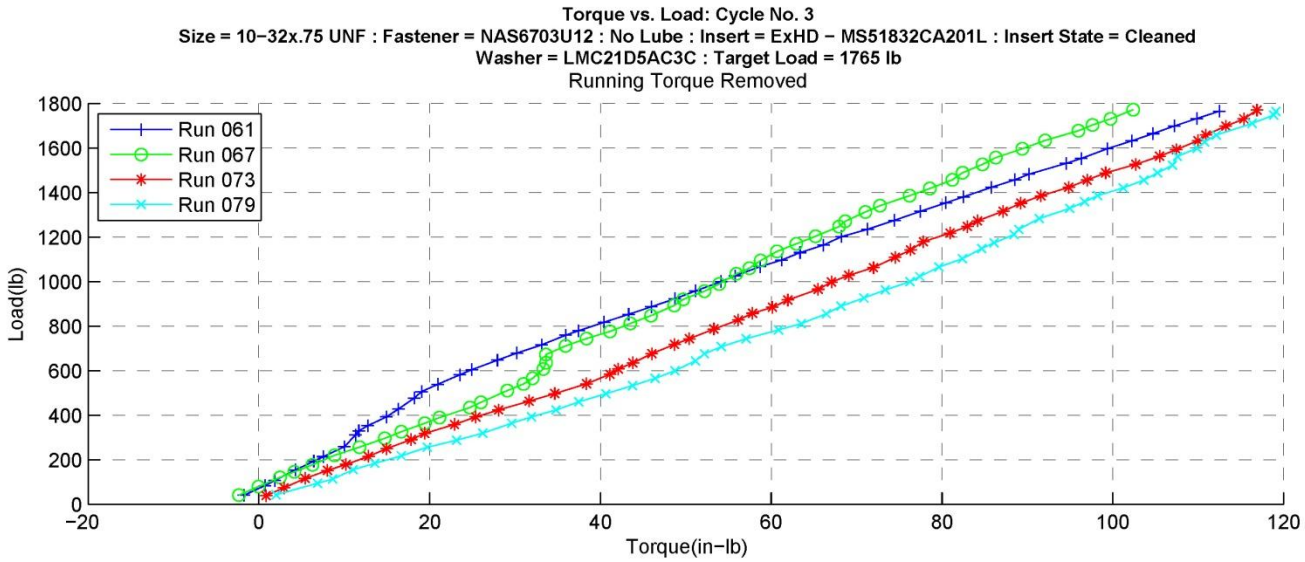

Running Torque Included
Run 006
Run 012
Run 018
Run 028
Load(lb)
Torque(in−lb)

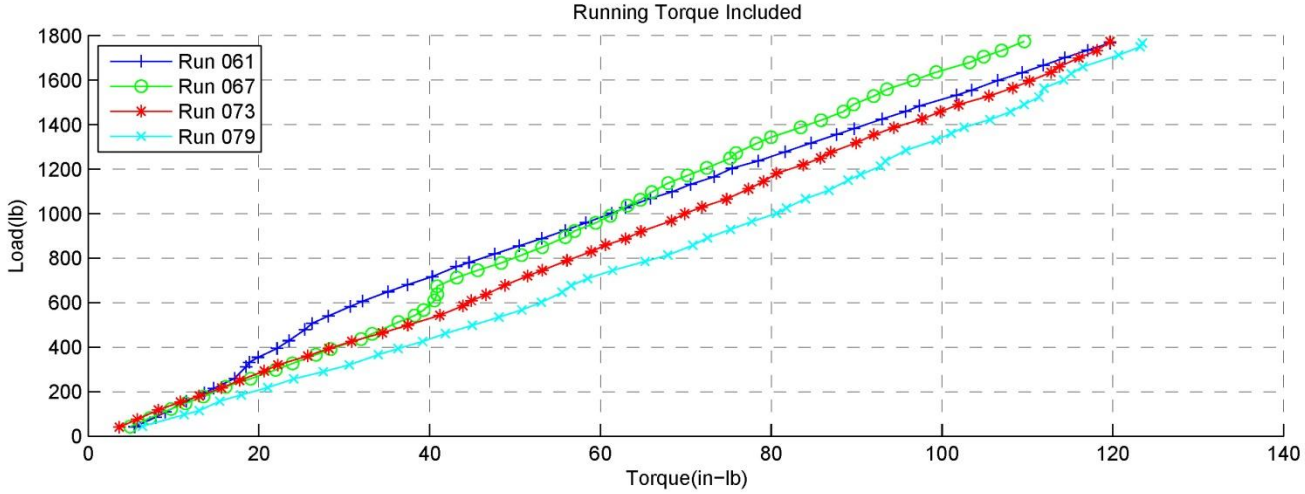

Torque vs. Load: Cycle No. 1
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : No Lube : Insert = ExHD − MS51832CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 059
Run 065
Run 071
Run 077
Load(lb)
Torque(in−lb)

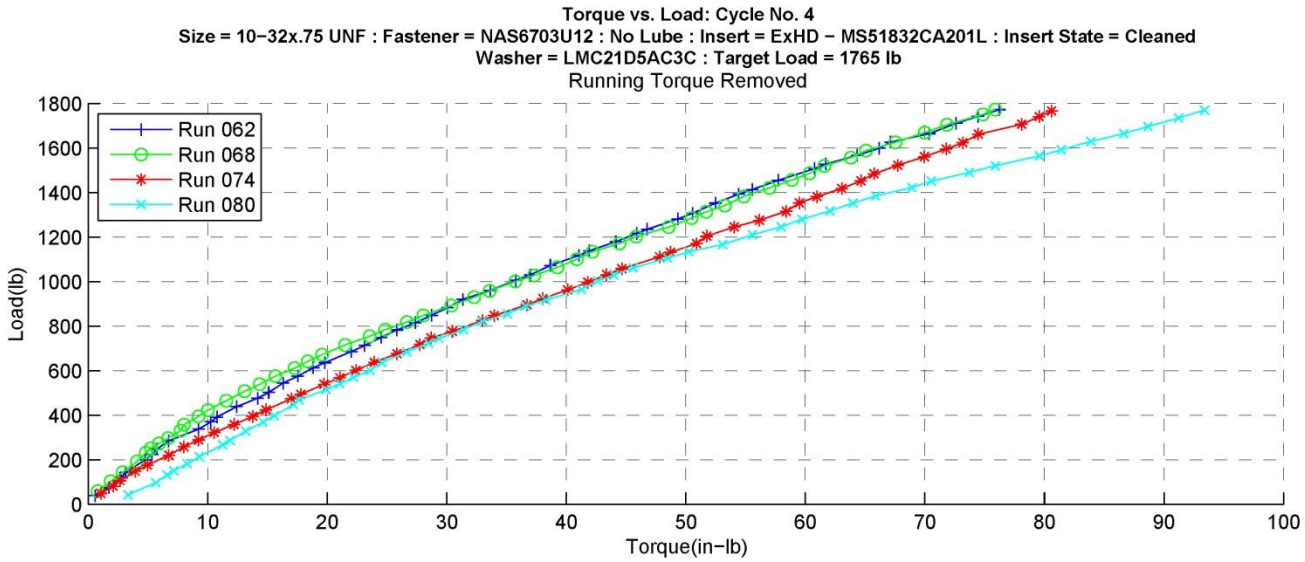

Running Torque Included
Run 059
Run 065
Run 071
Run 077
Load(lb)
Torque(in−lb)

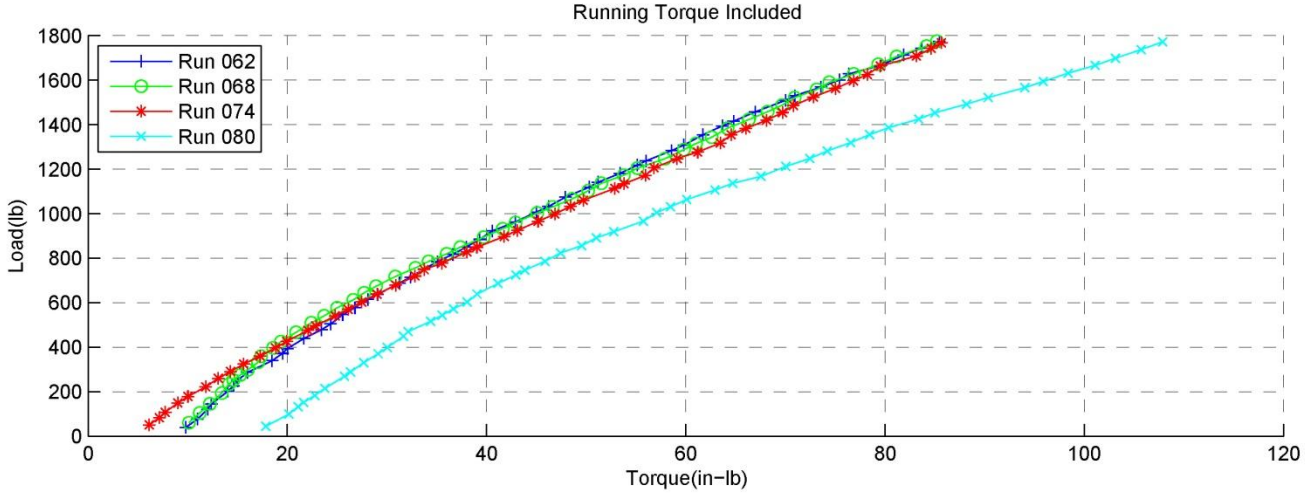

Torque vs. Load: Cycle No. 2
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : No Lube : Insert = ExHD − MS51832CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 060
Run 066
Run 072
Run 078
Load(lb)
Torque(in−lb)

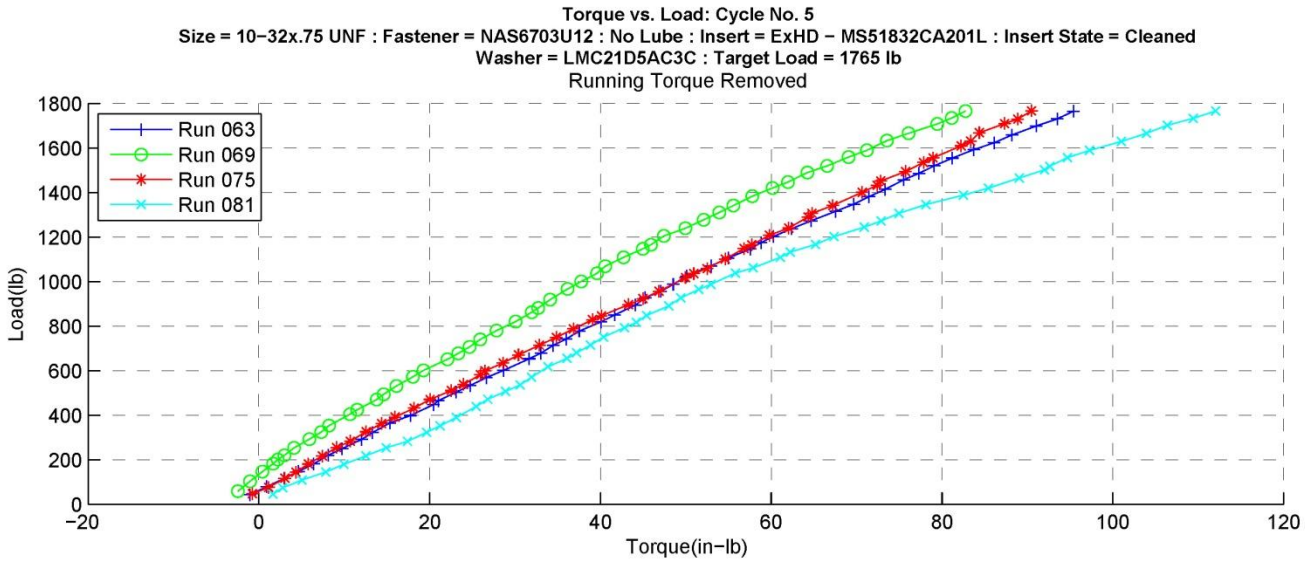

Running Torque Included
Run 060
Run 066
Run 072
Run 078
Load(lb)
Torque(in−lb)

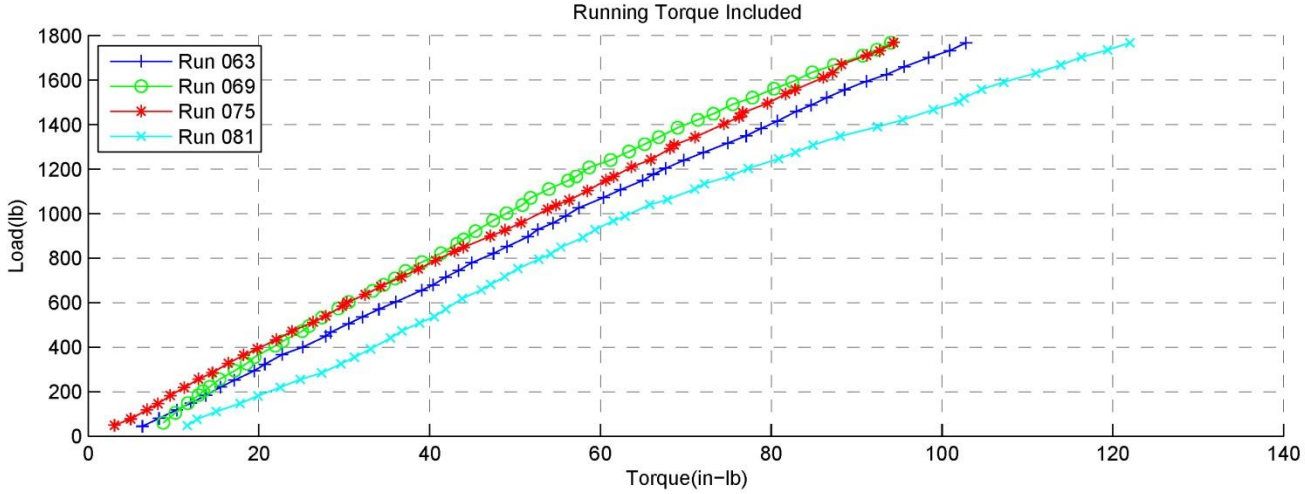

Torque vs. Load: Cycle No. 3
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : No Lube : Insert = ExHD − MS51832CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 061
Run 067
Run 073
Run 079
Load(lb)
Torque(in−lb)

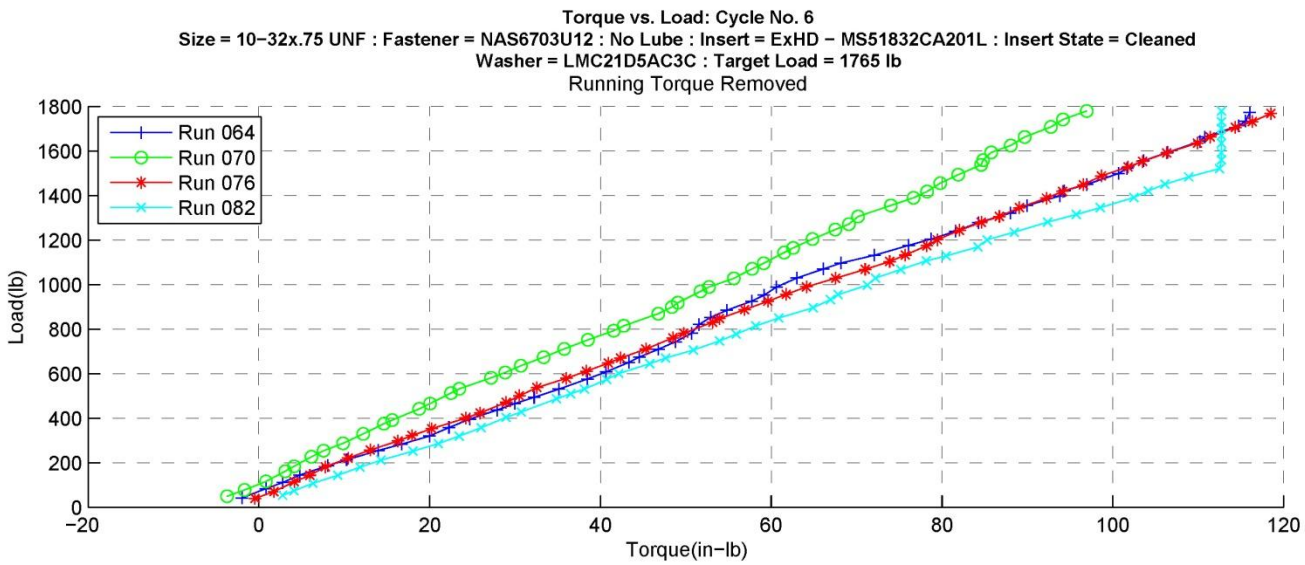

Running Torque Included
Run 061
Run 067
Run 073
Run 079
Load(lb)
Torque(in−lb)

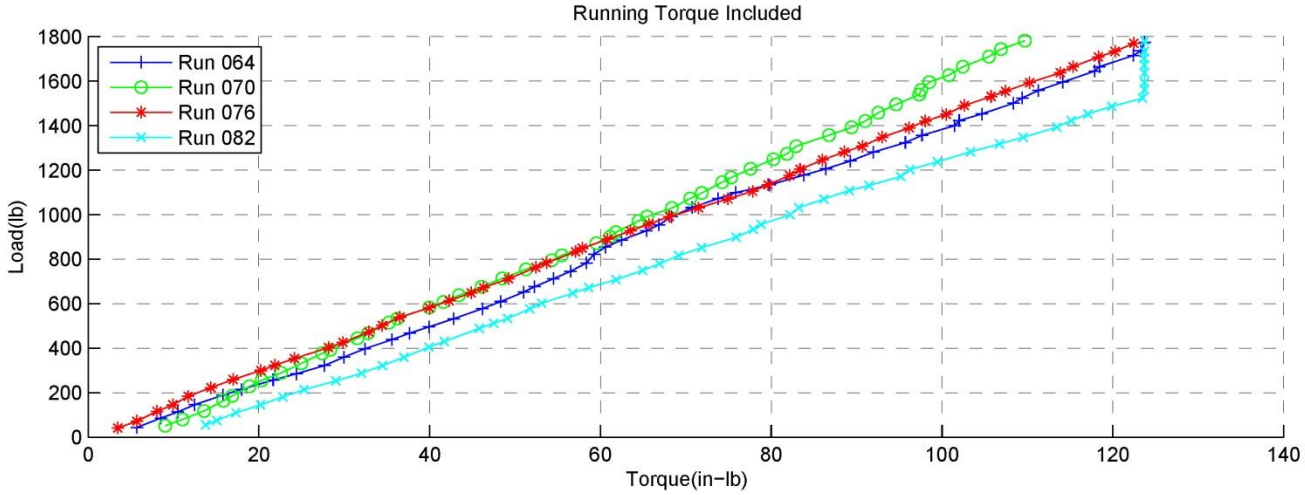

Torque vs. Load: Cycle No. 4
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : No Lube : Insert = ExHD − MS51832CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 062
Run 068
Run 074
Run 080
Load(lb)
Torque(in−lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
10
20
30
40
50
60
70
80
90
100

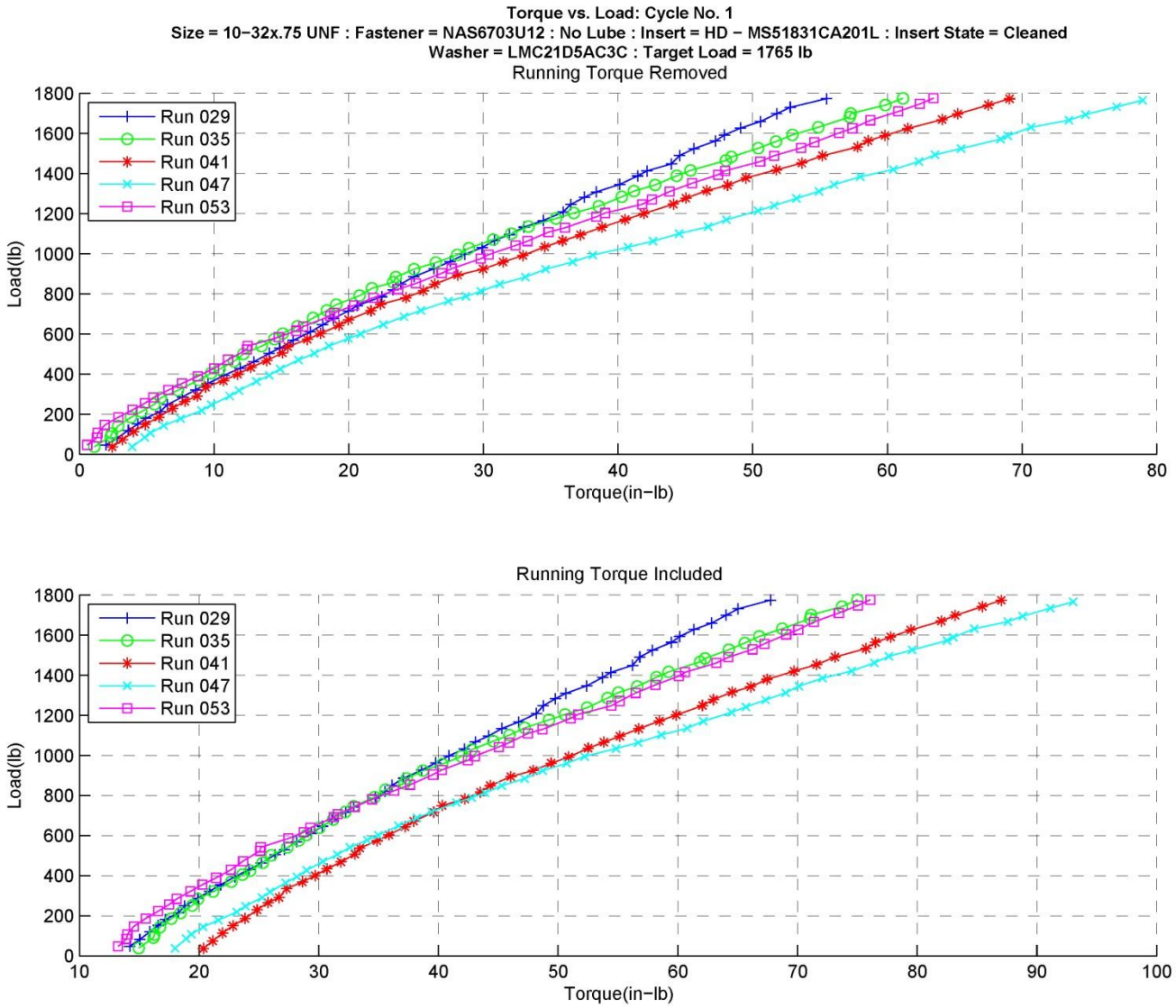

Running Torque Included
Run 062
Run 068
Run 074
Run 080
Load(lb)
Torque(in−lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
20
40
60
80
100
120

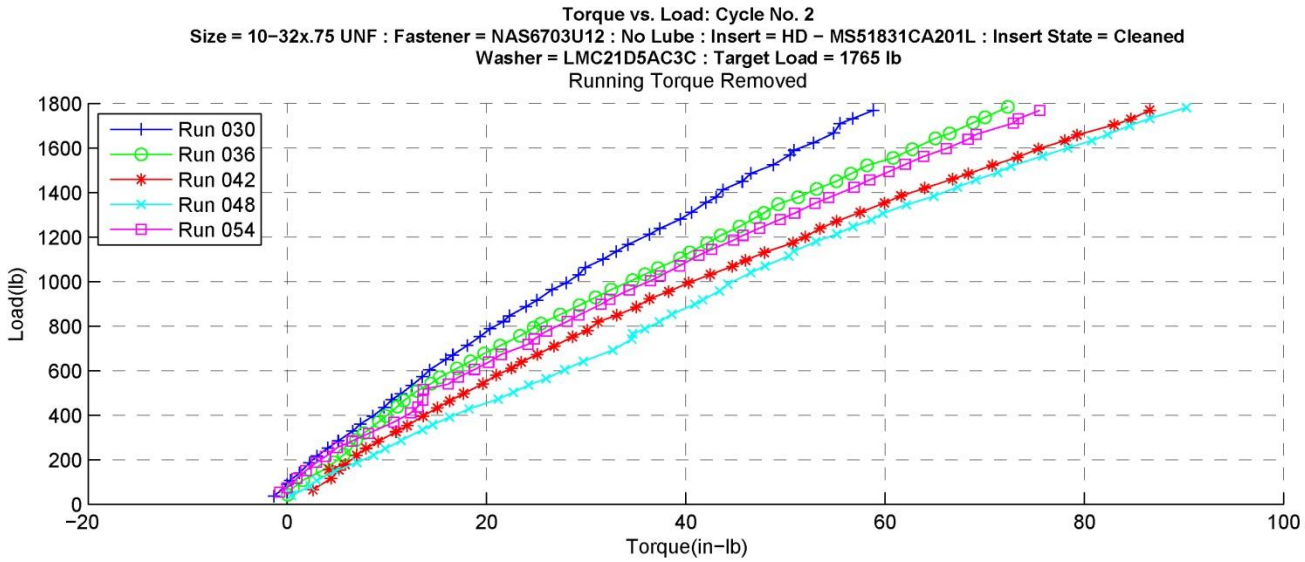

Torque vs. Load: Cycle No. 5
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : No Lube : Insert = ExHD − MS51832CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 063
Run 069
Run 075
Run 081
Load(lb)
Torque(in−lb)

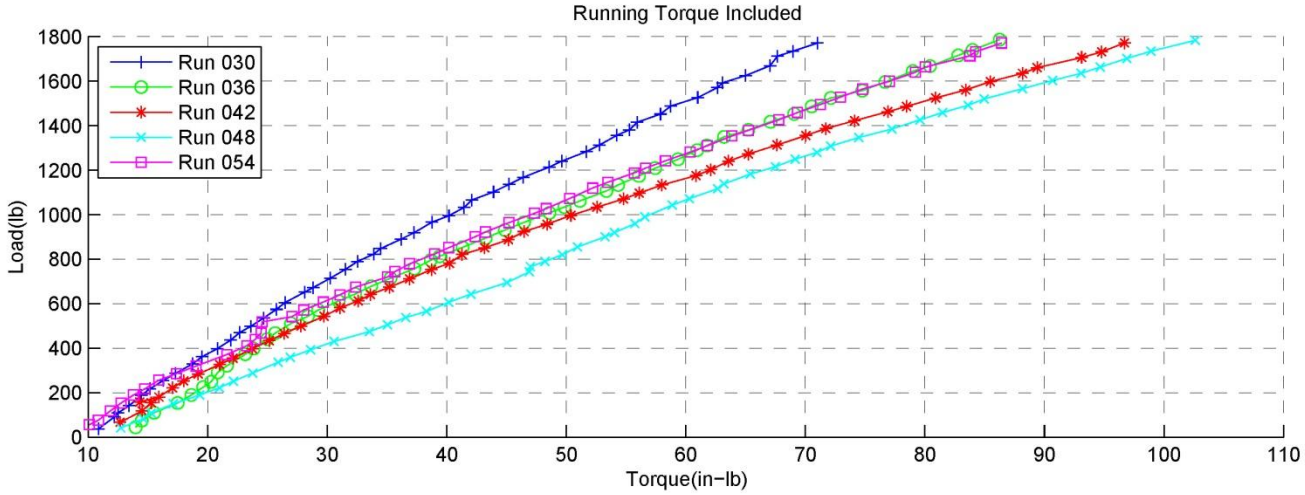

Running Torque Included
Run 063
Run 069
Run 075
Run 081
Load(lb)
Torque(in−lb)

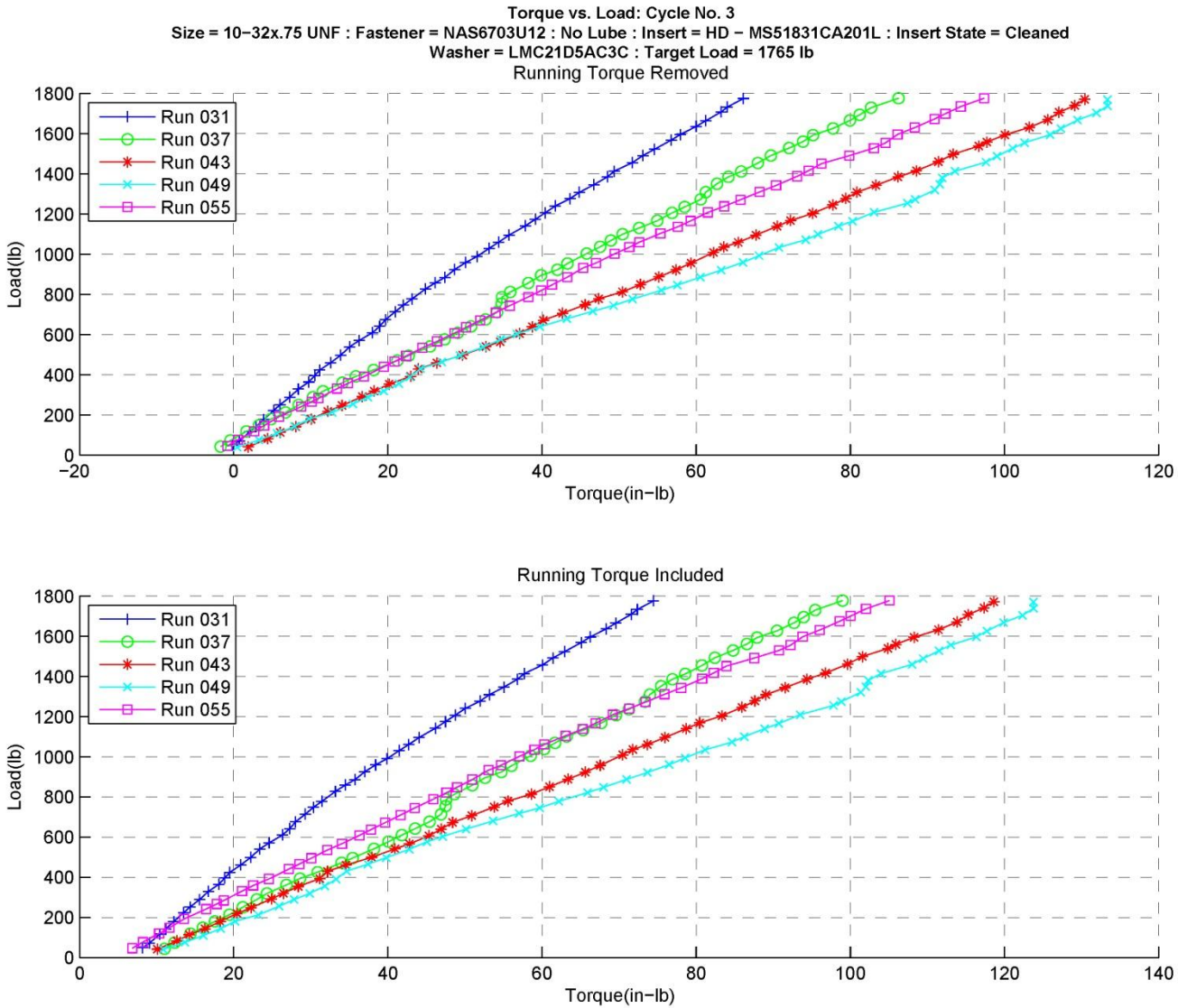

Torque vs. Load: Cycle No. 6
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : No Lube : Insert = ExHD − MS51832CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 064
Run 070
Run 076
Run 082
Load(lb)
Torque(in−lb)

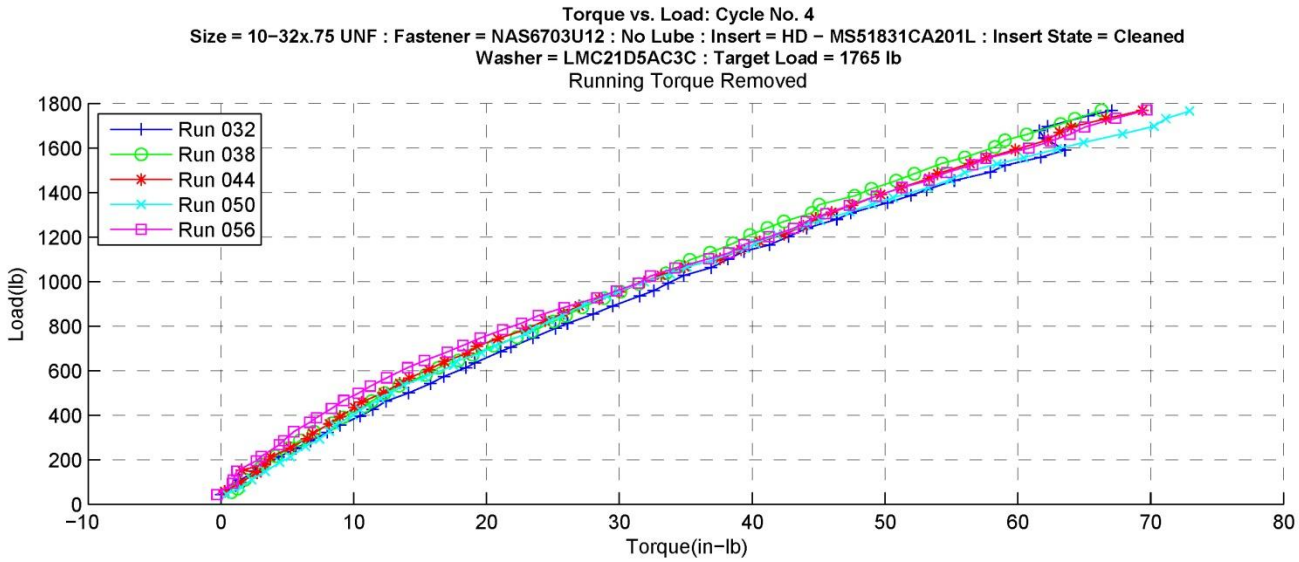

Running Torque Included
Run 064
Run 070
Run 076
Run 082
Load(lb)
Torque(in−lb)

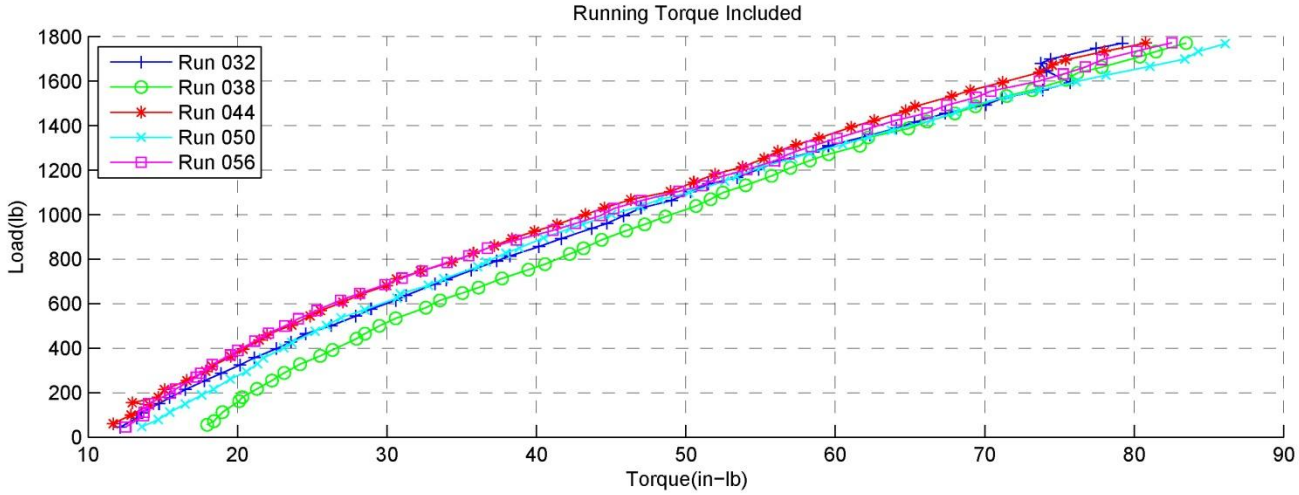

Torque vs. Load: Cycle No. 1
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : No Lube : Insert = HD − MS51831CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 029
Run 035
Run 041
Run 047
Run 053
Load(lb)
Torque(in−lb)
Running Torque Included
Run 029
Run 035
Run 041
Run 047
Run 053
Load(lb)
Torque(in−lb)

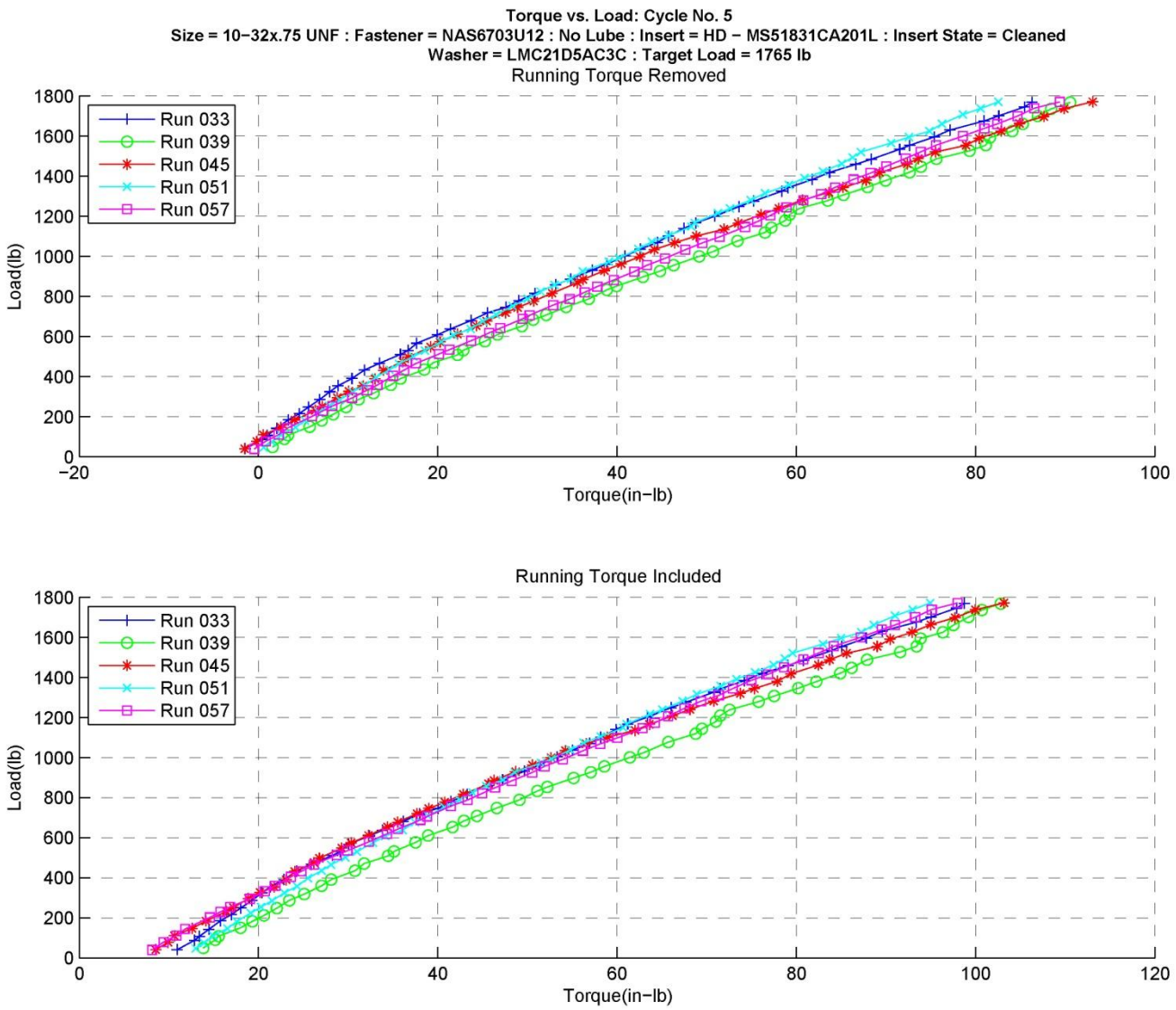

Torque vs. Load: Cycle No. 2
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : No Lube : Insert = HD − MS51831CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 030
Run 036
Run 042
Run 048
Run 054
Load(lb)
Torque(in−lb)

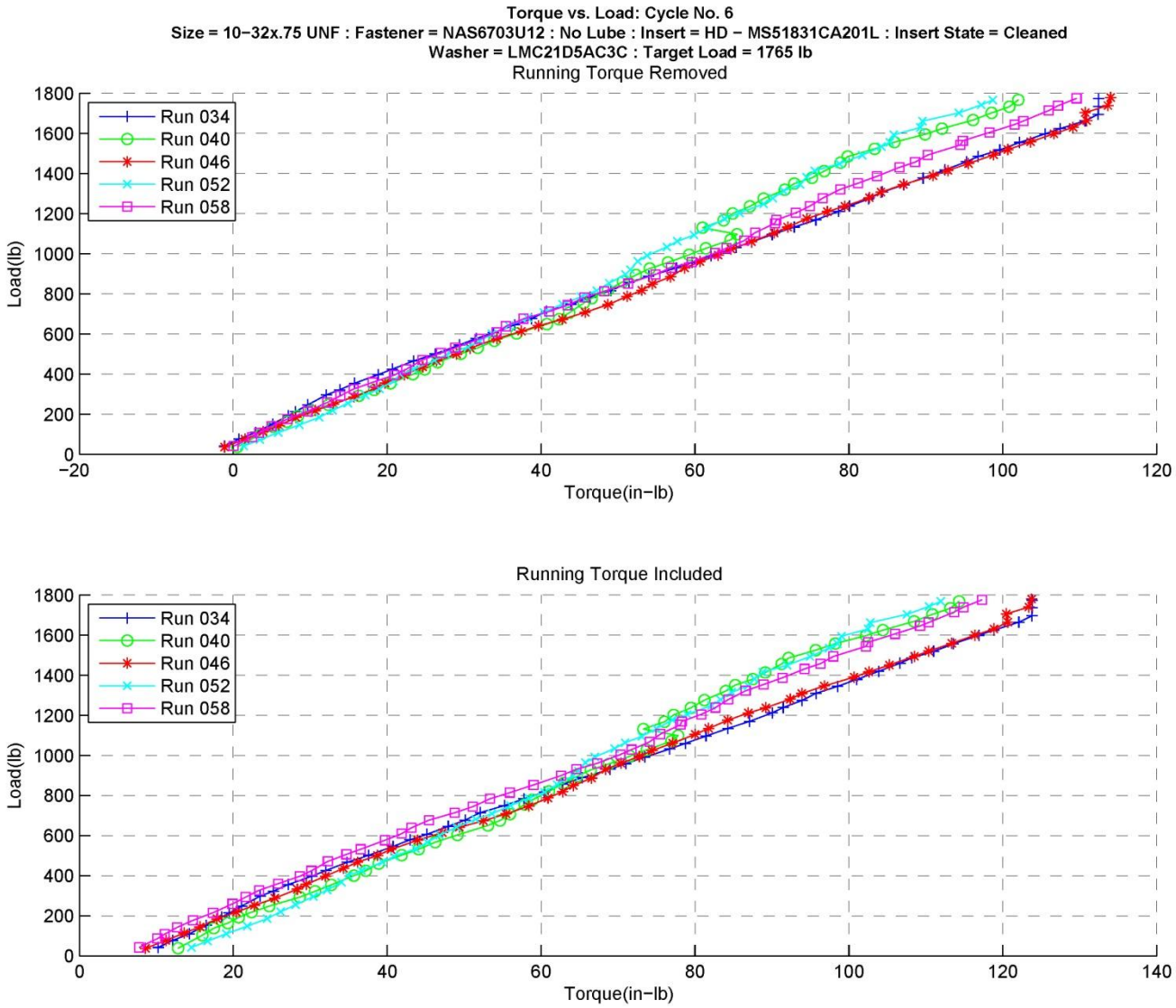

Running Torque Included
Run 030
Run 036
Run 042
Run 048
Run 054
Load(lb)
Torque(in−lb)


Torque vs. Load: Cycle No. 3
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : No Lube : Insert = HD − MS51831CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 031
Run 037
Run 043
Run 049
Run 055
Load(lb)
Torque(in−lb)
Running Torque Included
Run 031
Run 037
Run 043
Run 049
Run 055
Load(lb)
Torque(in−lb)


Torque vs. Load: Cycle No. 4
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : No Lube : Insert = HD − MS51831CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 032
Run 038
Run 044
Run 050
Run 056
Load(lb)
Torque(in−lb)

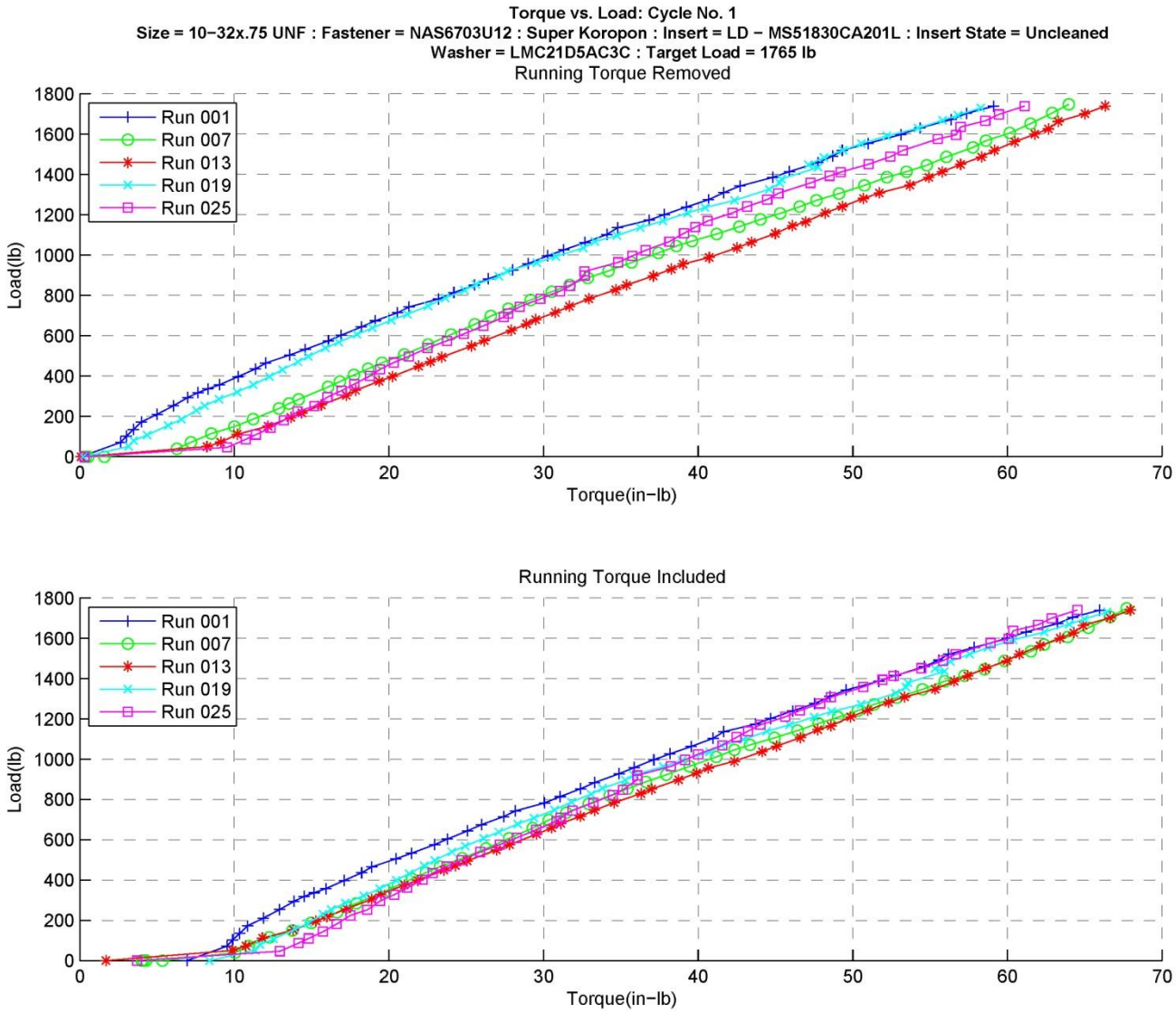

Running Torque Included
Run 032
Run 038
Run 044
Run 050
Run 056
Load(lb)
Torque(in−lb)

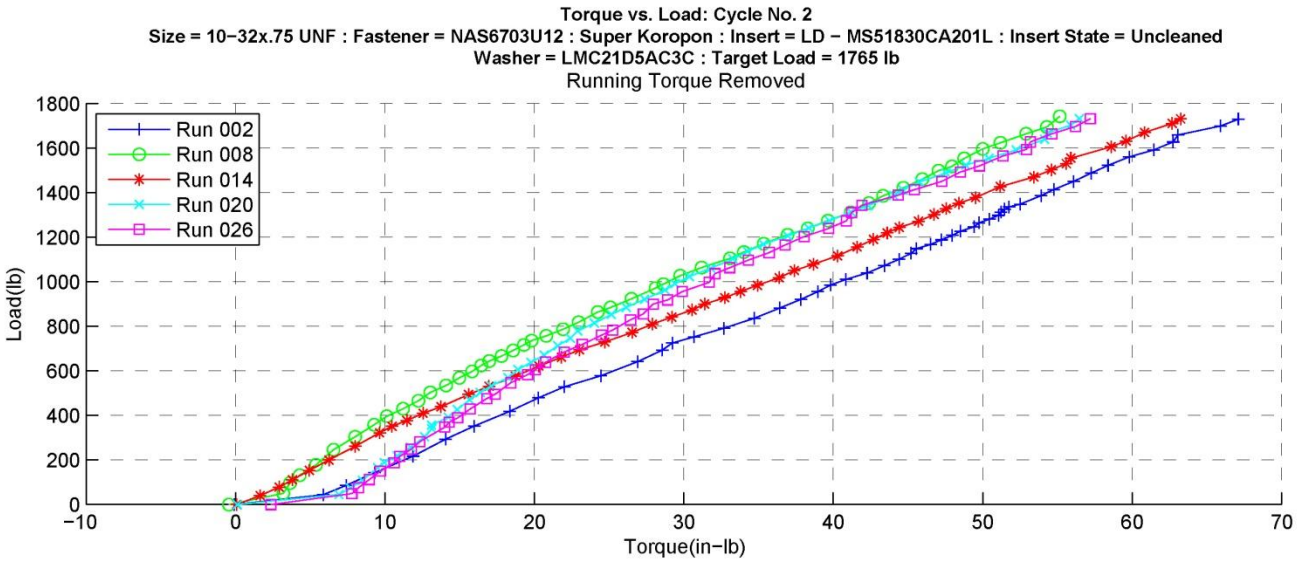

Torque vs. Load: Cycle No. 5
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : No Lube : Insert = HD − MS51831CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 033
Run 039
Run 045
Run 051
Run 057
Load(lb)
Torque(in−lb)
Running Torque Included
Run 033
Run 039
Run 045
Run 051
Run 057
Load(lb)
Torque(in−lb)

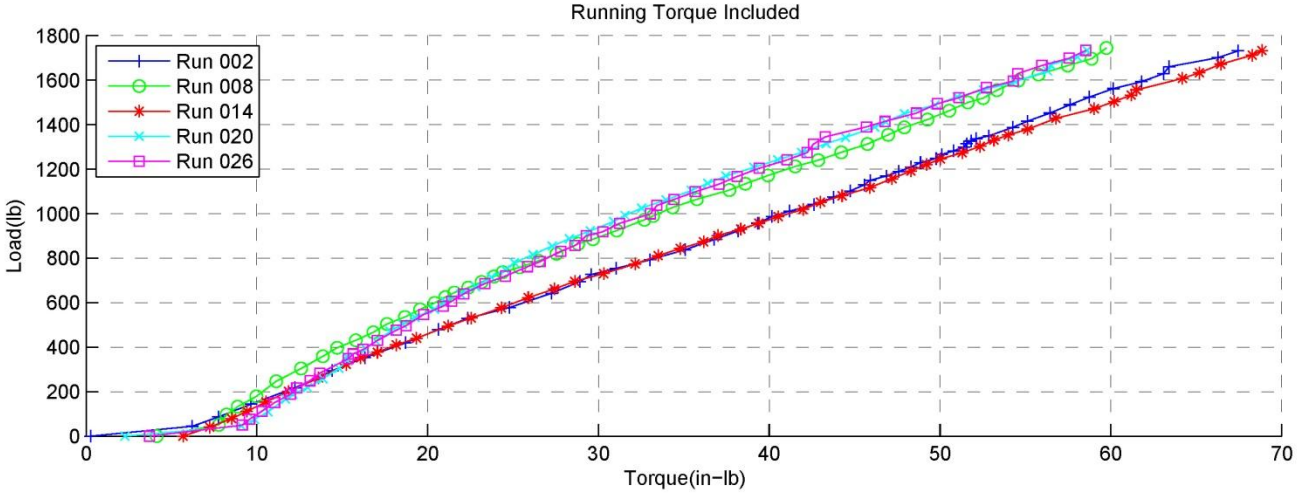

Torque vs. Load: Cycle No. 6
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : No Lube : Insert = HD − MS51831CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 034
Run 040
Run 046
Run 052
Run 058
Load(lb)
Torque(in−lb)
Running Torque Included
Run 034
Run 040
Run 046
Run 052
Run 058
Load(lb)
Torque(in−lb)

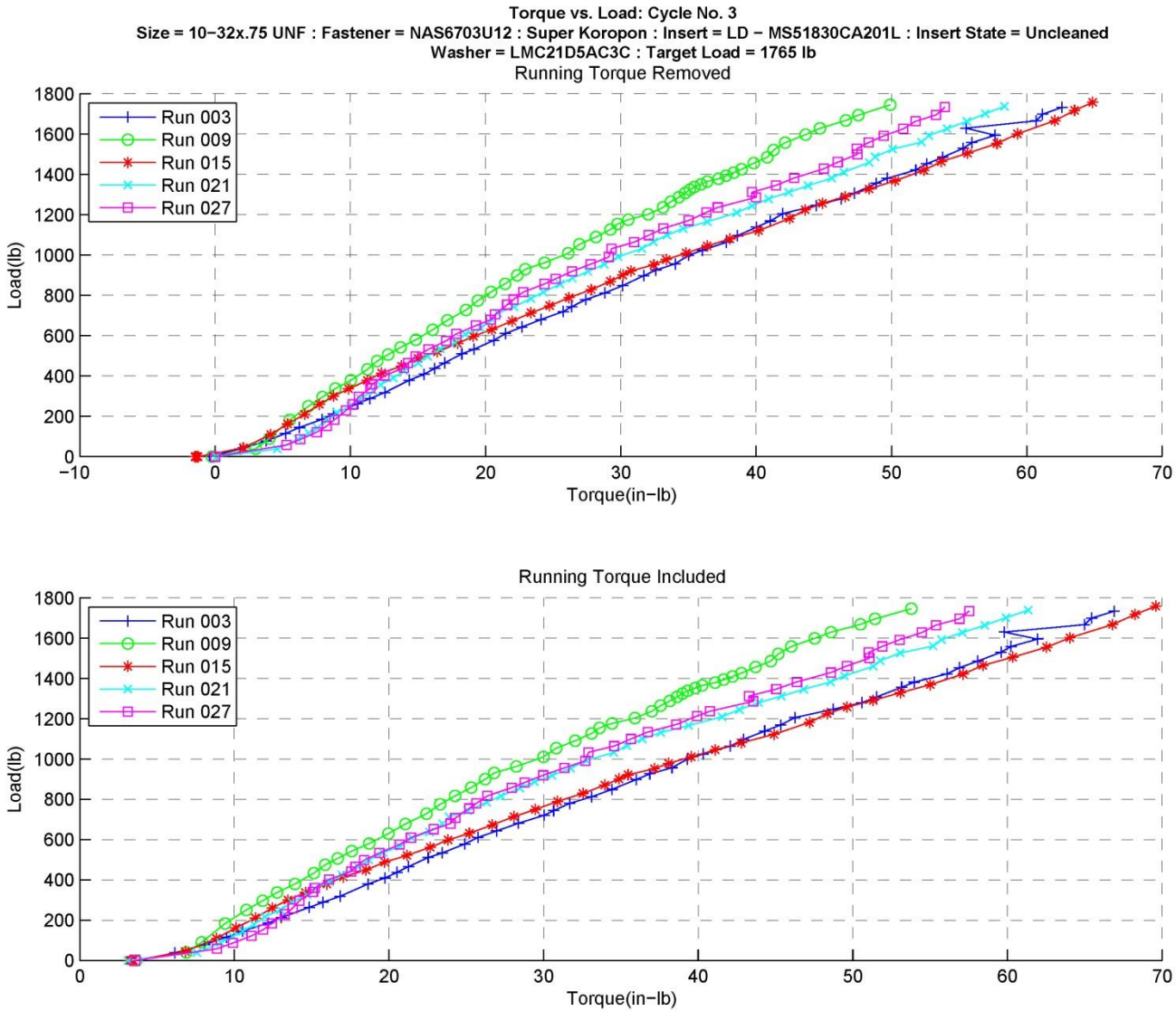
Appendix A:

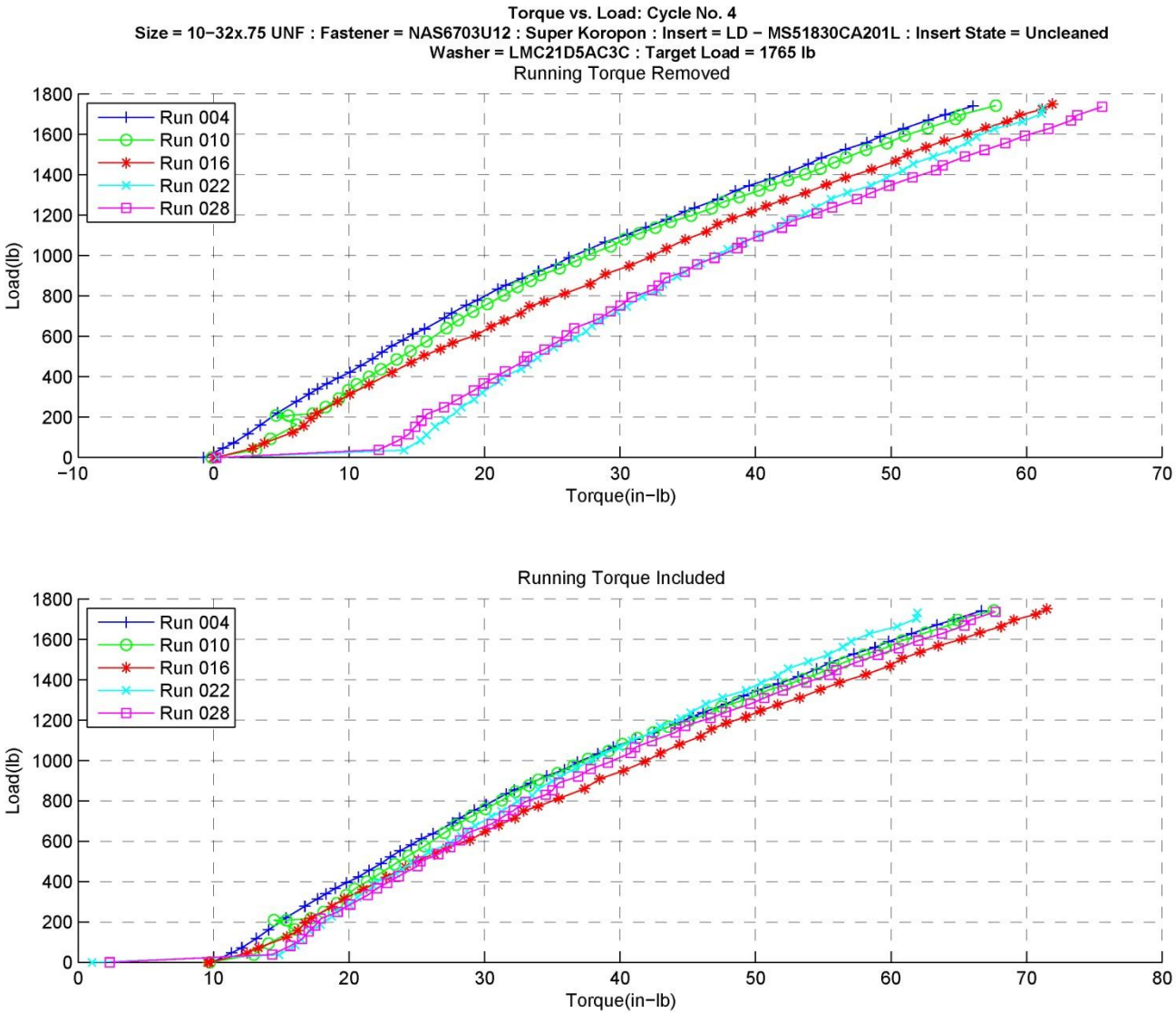
Section 1	10-32 Dry Torque Tension Plots
Section 2	10-32 Wet Torque Tension Plots
Section 3	10-32 Dry Running Torque Plots
Section 4	10-32 Wet Running Torque Plots
Section 5	10-32 Dry Cycle Plots: Torque vs. Load
Section 6	10-32 Wet Cycle Plots: Torque vs. Load
Section 7	10-32 Friction Coefficients
Section 8	10-32 Test Plate Layouts
Section 9	10-32 Dry Run Logs
Section 10	10-32 Wet Run Logs

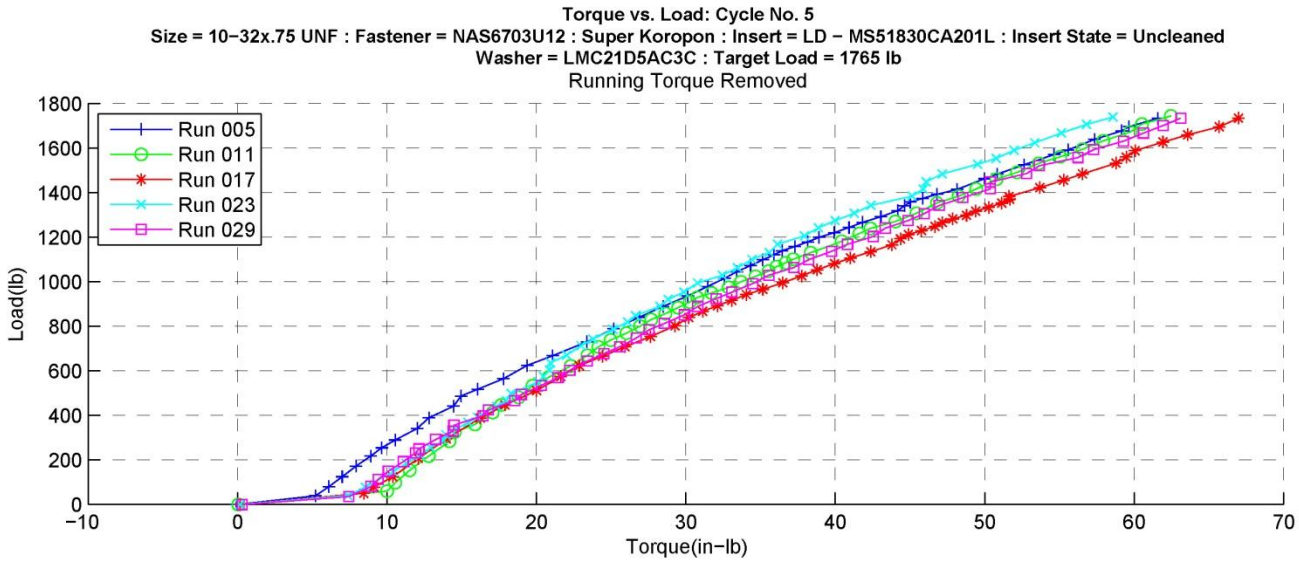

Torque vs. Load: Cycle No. 1
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Super Koropon : Insert = LD − MS51830CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 001
Run 007
Run 013
Run 019
Run 025
Load(lb)
Torque(in−lb)
Running Torque Included
Run 001
Run 007
Run 013
Run 019
Run 025
Load(lb)
Torque(in−lb)

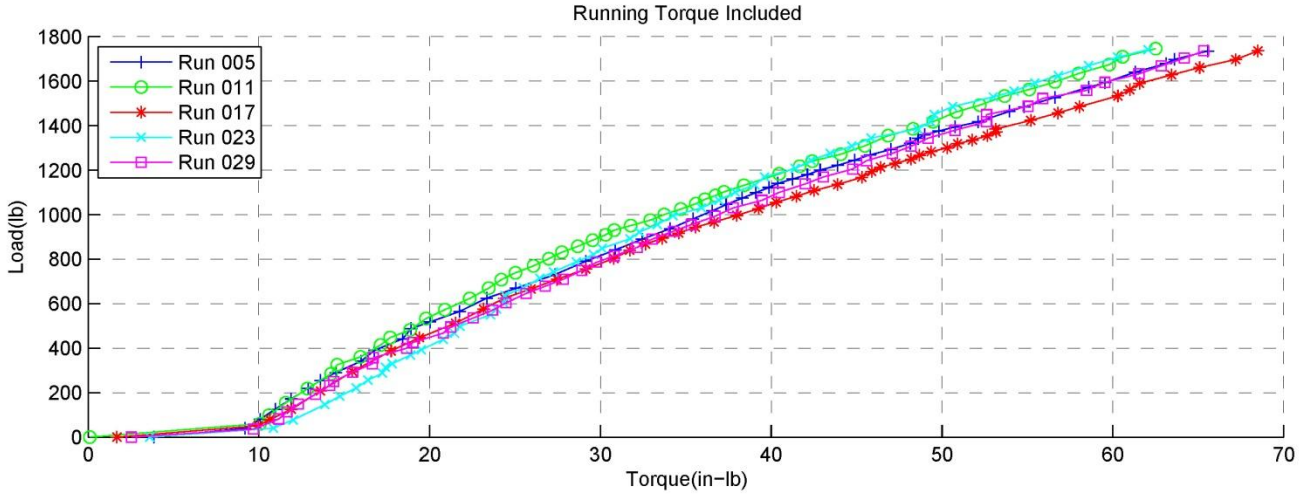

Torque vs. Load: Cycle No. 2
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Super Koropon : Insert = LD − MS51830CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 002
Run 008
Run 014
Run 020
Run 026
Load(lb)
Torque(in−lb)

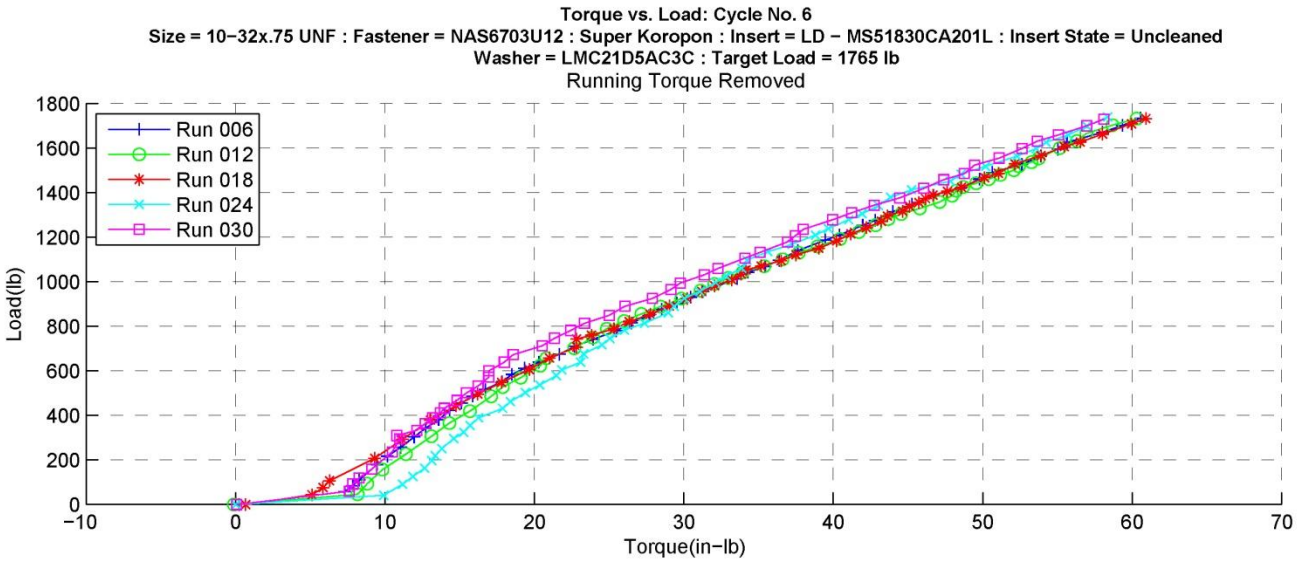

Running Torque Included
Run 002
Run 008
Run 014
Run 020
Run 026
Load(lb)
Torque(in−lb)

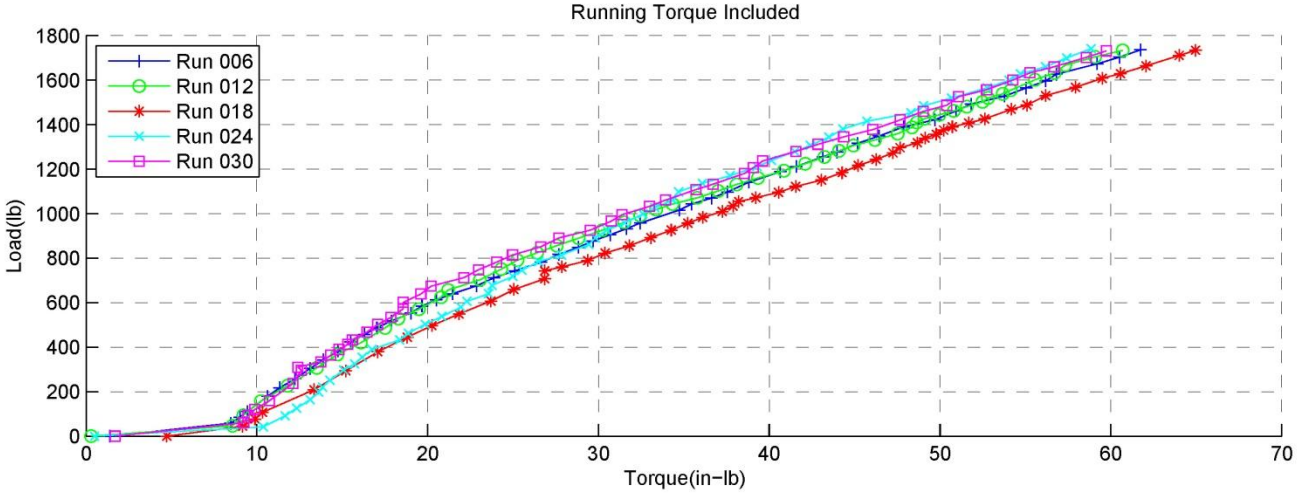

Torque vs. Load: Cycle No. 3
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Super Koropon : Insert = LD − MS51830CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 003
Run 009
Run 015
Run 021
Run 027
Load(lb)
Torque(in−lb)
Running Torque Included
Run 003
Run 009
Run 015
Run 021
Run 027
Load(lb)
Torque(in−lb)

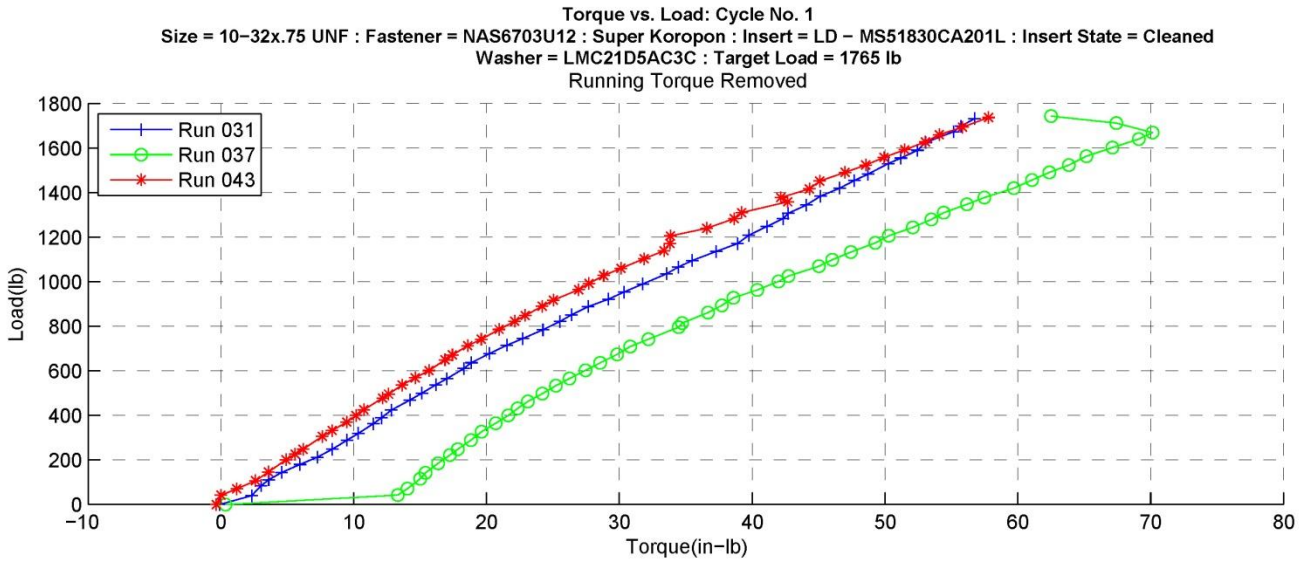

Torque vs. Load: Cycle No. 4
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Super Koropon : Insert = LD − MS51830CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 004
Run 010
Run 016
Run 022
Run 028
Load(lb)
Torque(in−lb)
Running Torque Included
Run 004
Run 010
Run 016
Run 022
Run 028
Load(lb)
Torque(in−lb)

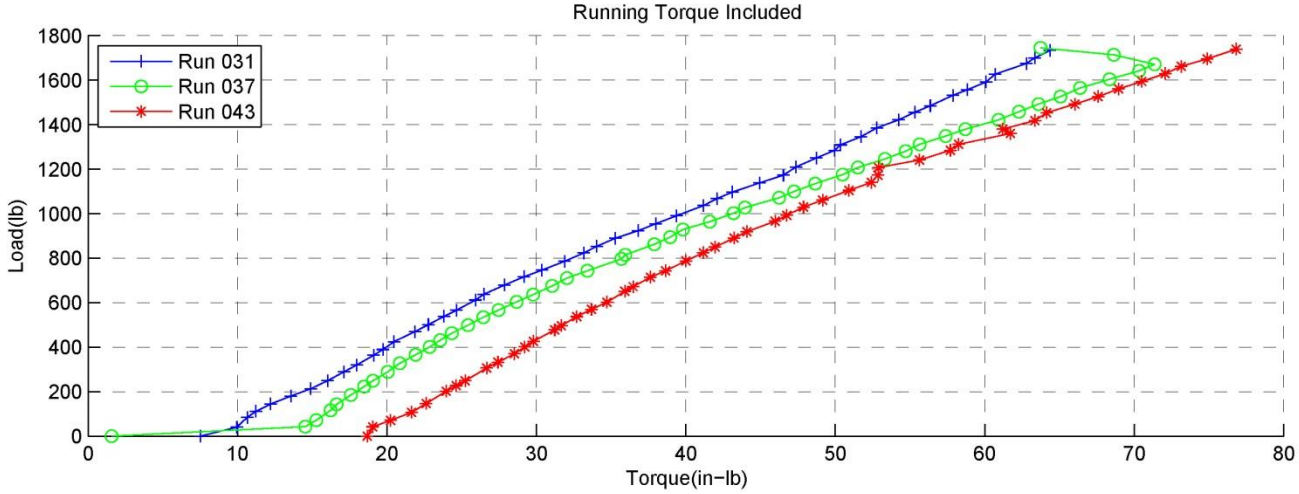

Torque vs. Load: Cycle No. 5
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Super Koropon : Insert = LD − MS51830CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 005
Run 011
Run 017
Run 023
Run 029
Load(lb)
Torque(in−lb)

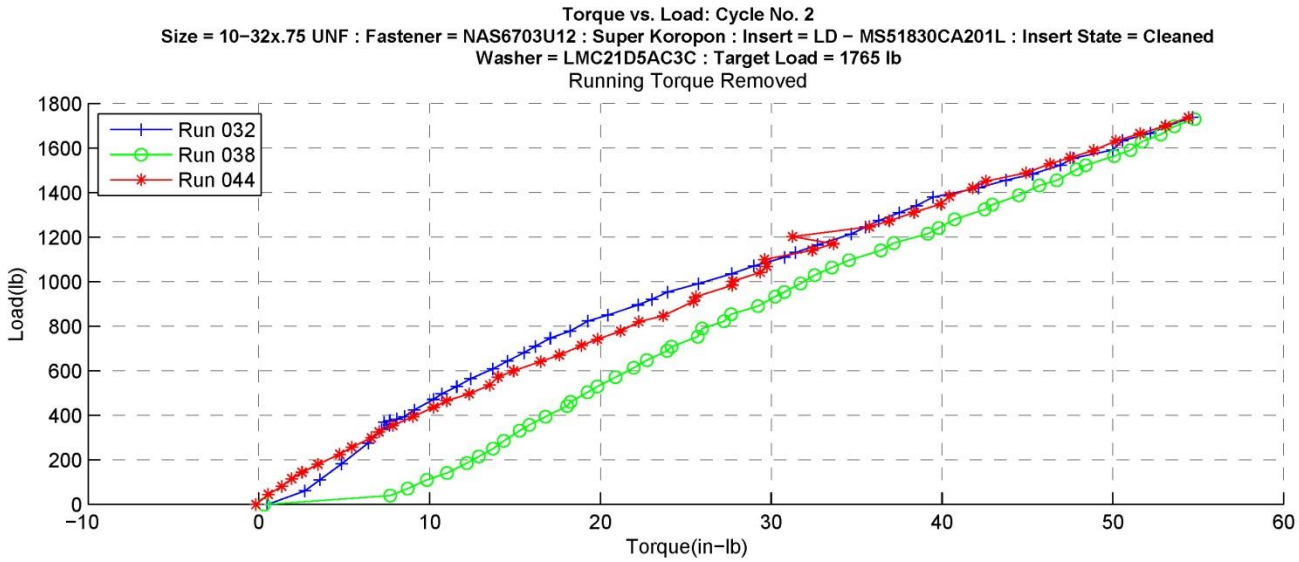

Running Torque Included
Run 005
Run 011
Run 017
Run 023
Run 029
Load(lb)
Torque(in−lb)

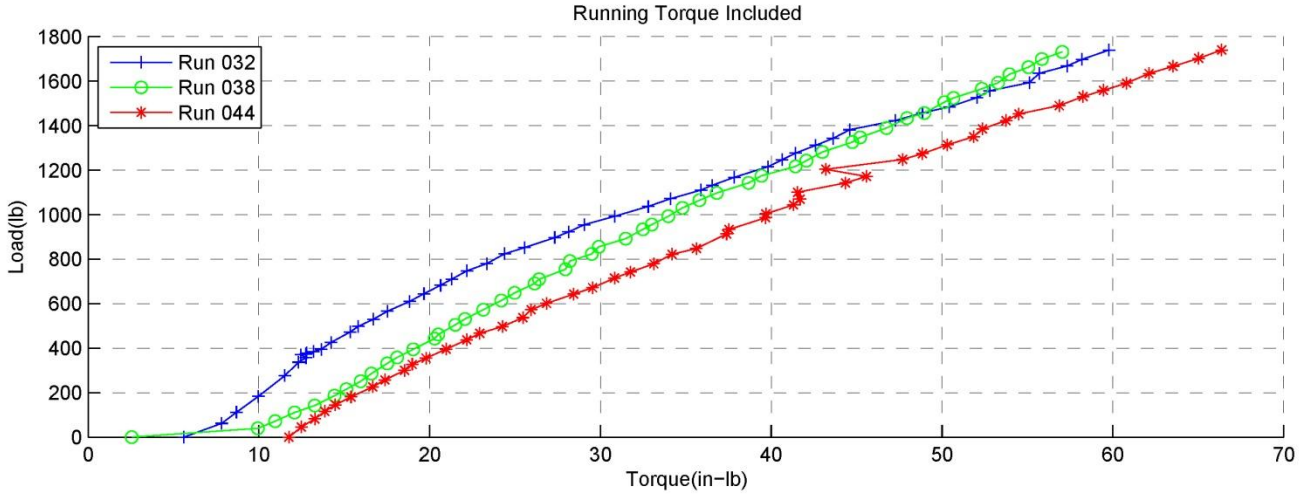

Torque vs. Load: Cycle No. 6
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Super Koropon : Insert = LD − MS51830CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 006
Run 012
Run 018
Run 024
Run 030
Load(lb)
Torque(in−lb)

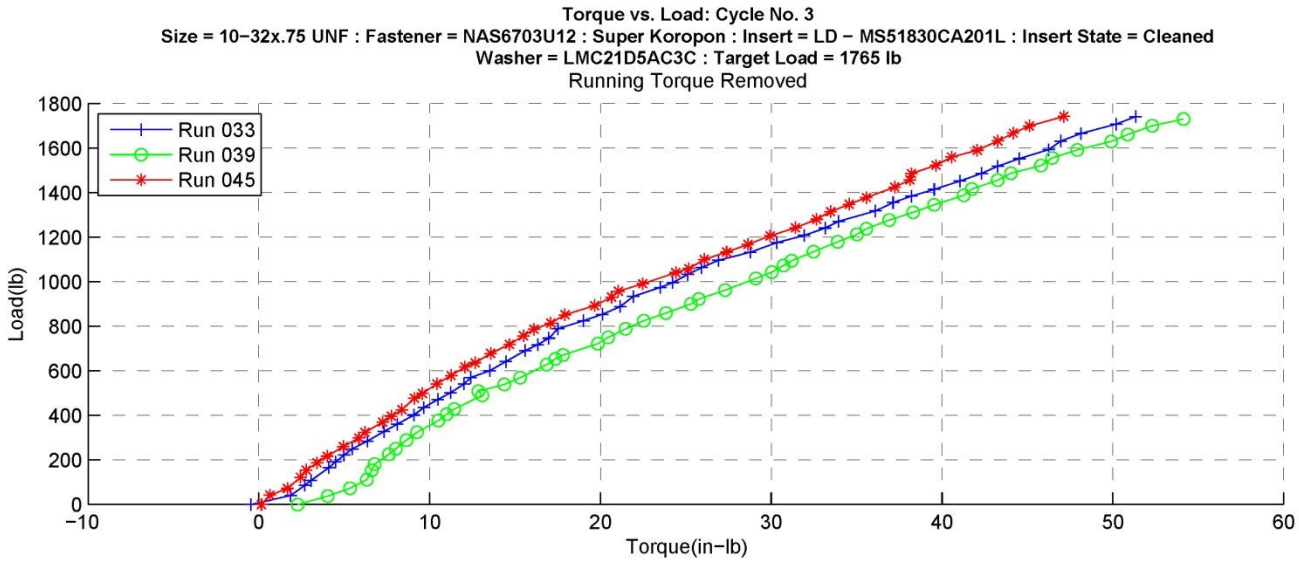

Running Torque Included
Run 006
Run 012
Run 018
Run 024
Run 030
Load(lb)
Torque(in−lb)

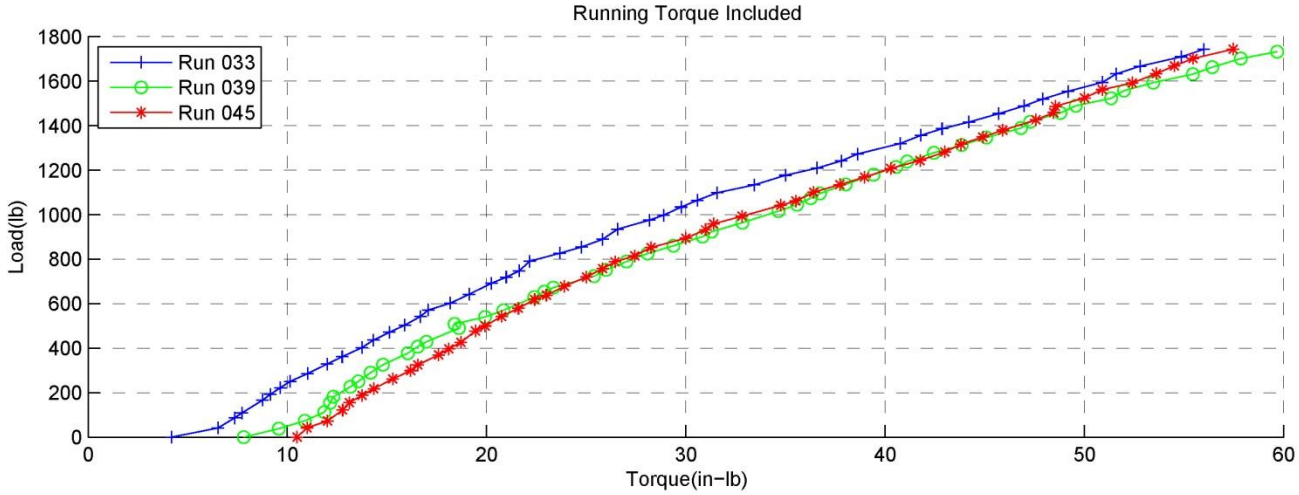

Torque vs. Load: Cycle No. 1
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Super Koropon : Insert = LD − MS51830CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 031
Run 037
Run 043
Load(lb)
Torque(in−lb)

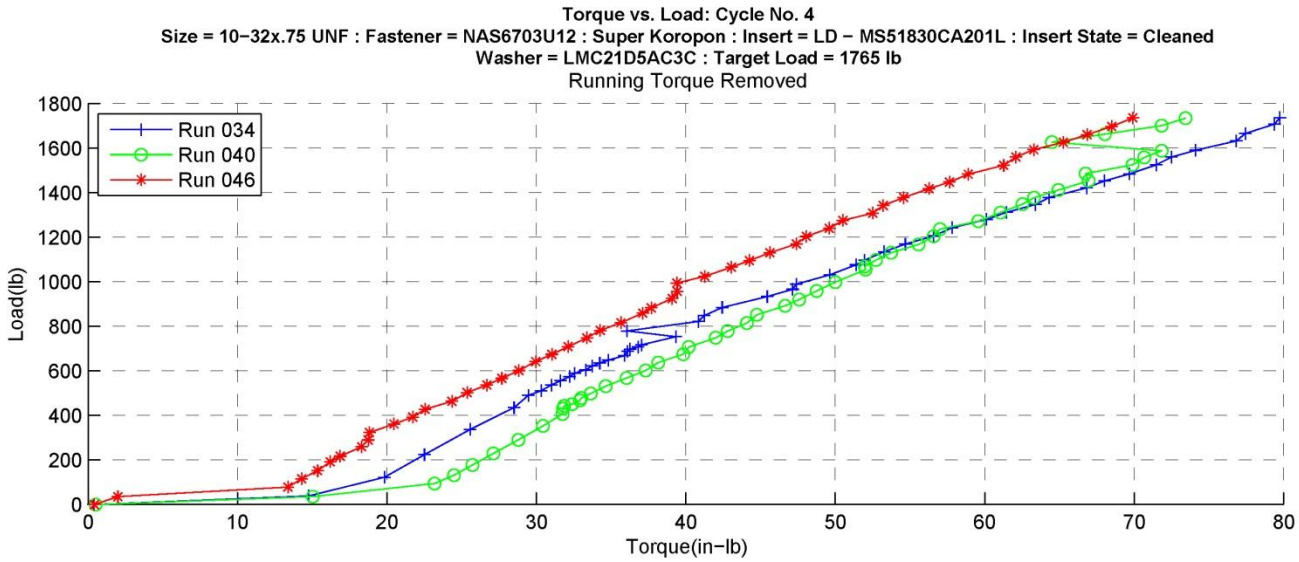

Running Torque Included
Run 031
Run 037
Run 043
Load(lb)
Torque(in−lb)

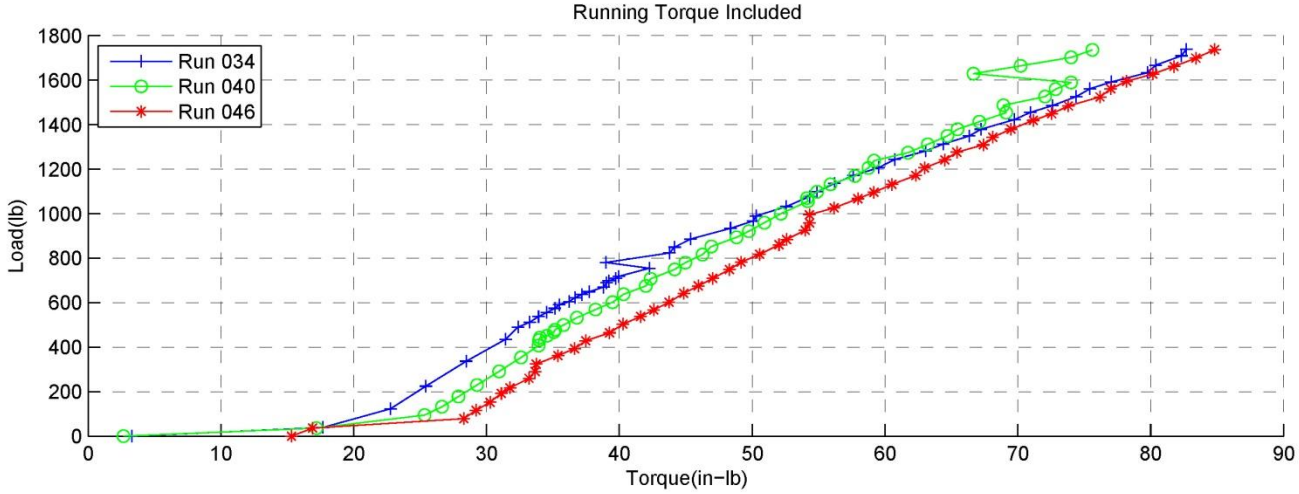

Torque vs. Load: Cycle No. 2
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Super Koropon : Insert = LD − MS51830CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 032
Run 038
Run 044
Load(lb)
Torque(in−lb)

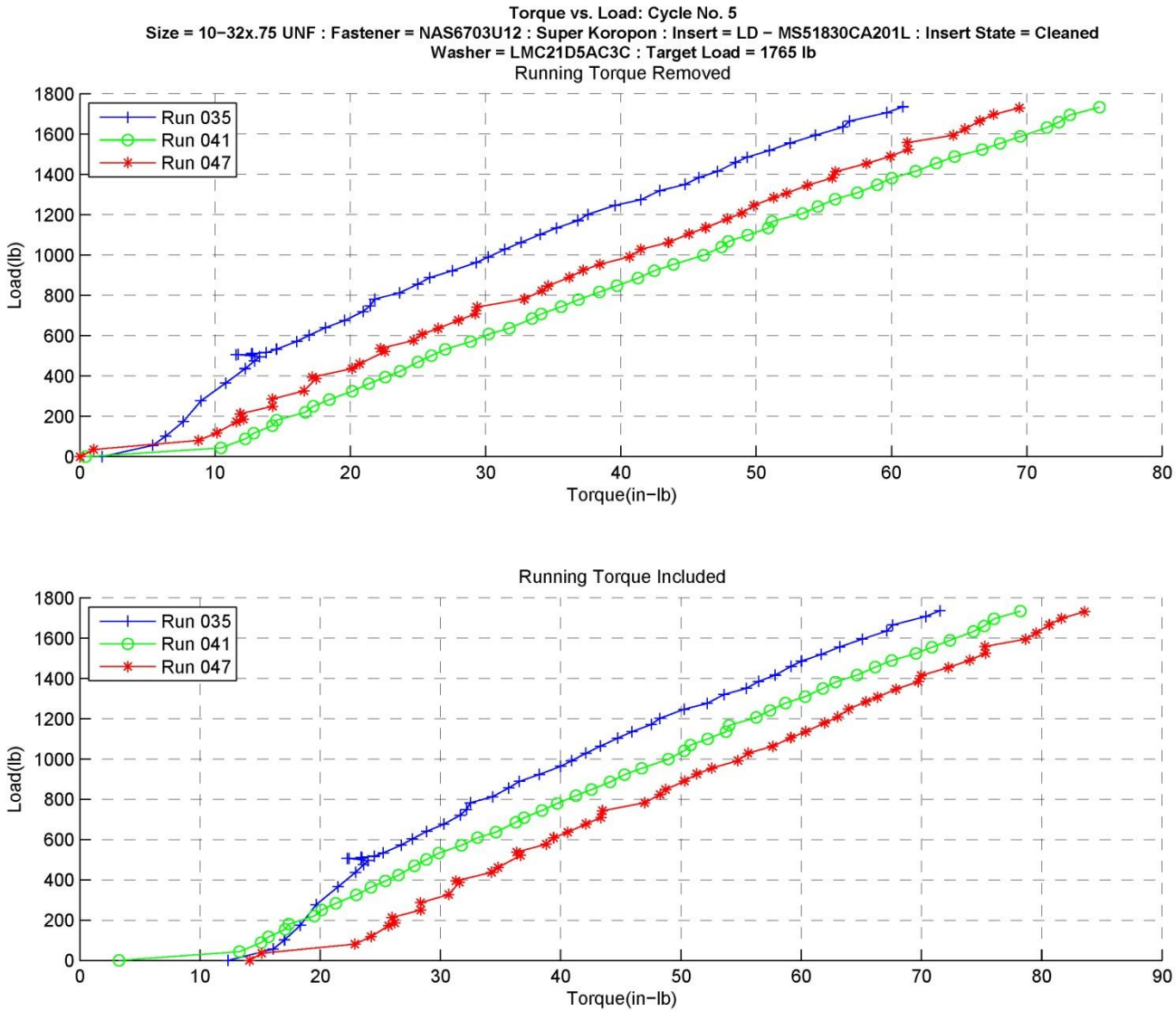

Running Torque Included
Run 032
Run 038
Run 044
Load(lb)
Torque(in−lb)

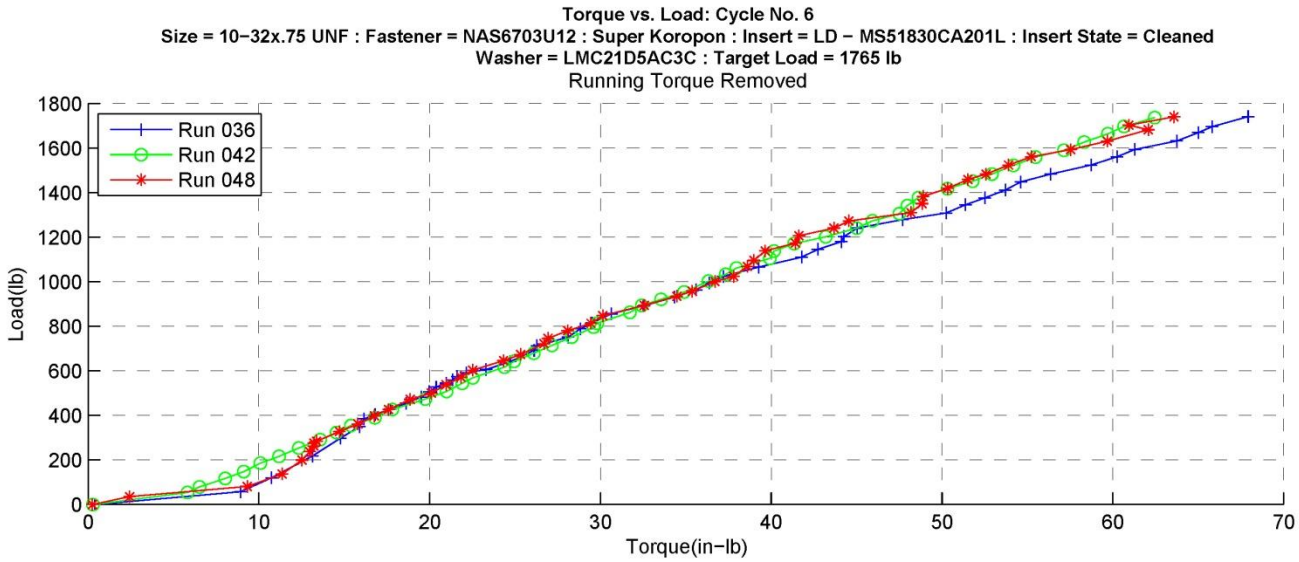

Torque vs. Load: Cycle No. 3
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Super Koropon : Insert = LD − MS51830CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 033
Run 039
Run 045
Load(lb)
Torque(in−lb)

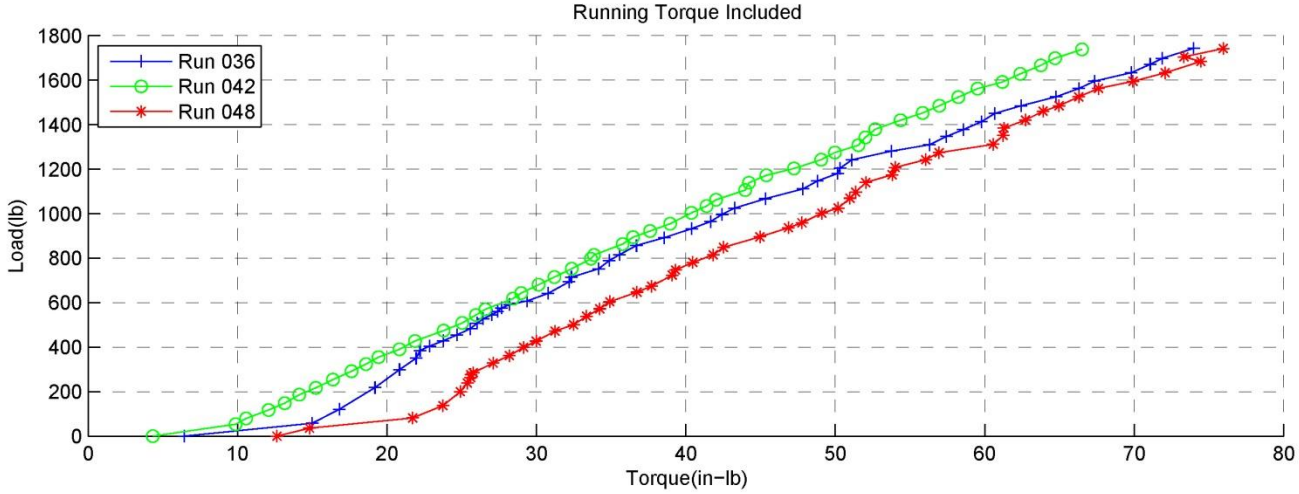

Running Torque Included
Run 033
Run 039
Run 045
Load(lb)
Torque(in−lb)

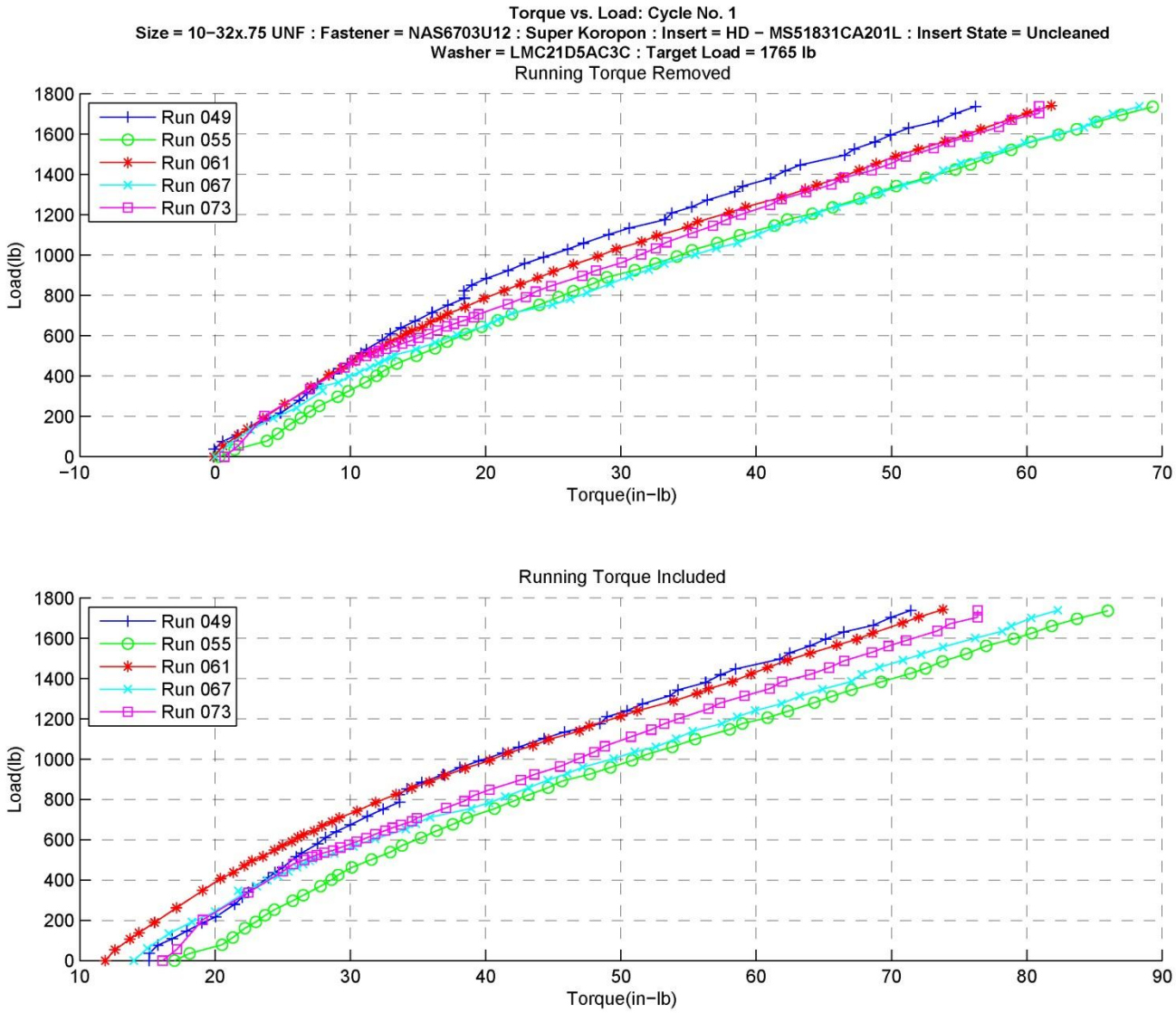

Torque vs. Load: Cycle No. 4
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Super Koropon : Insert = LD − MS51830CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 034
Run 040
Run 046
Load(lb)
Torque(in−lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
10
20
30
40
50
60
70
80

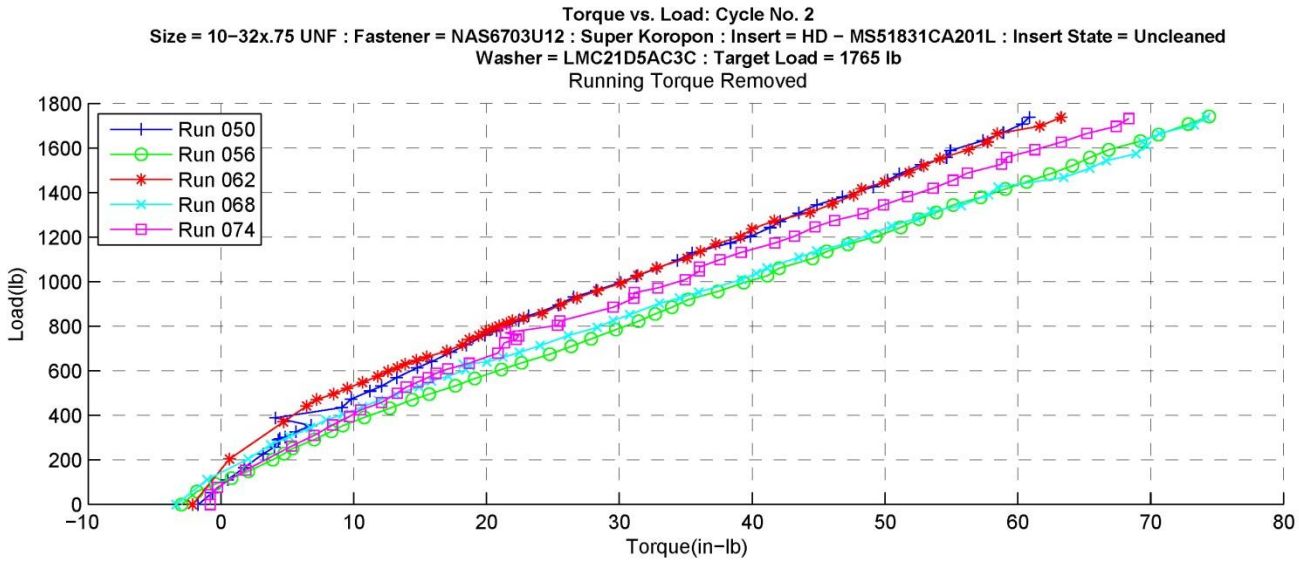

Running Torque Included
Run 034
Run 040
Run 046
Load(lb)
Torque(in−lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
10
20
30
40
50
60
70
80
90

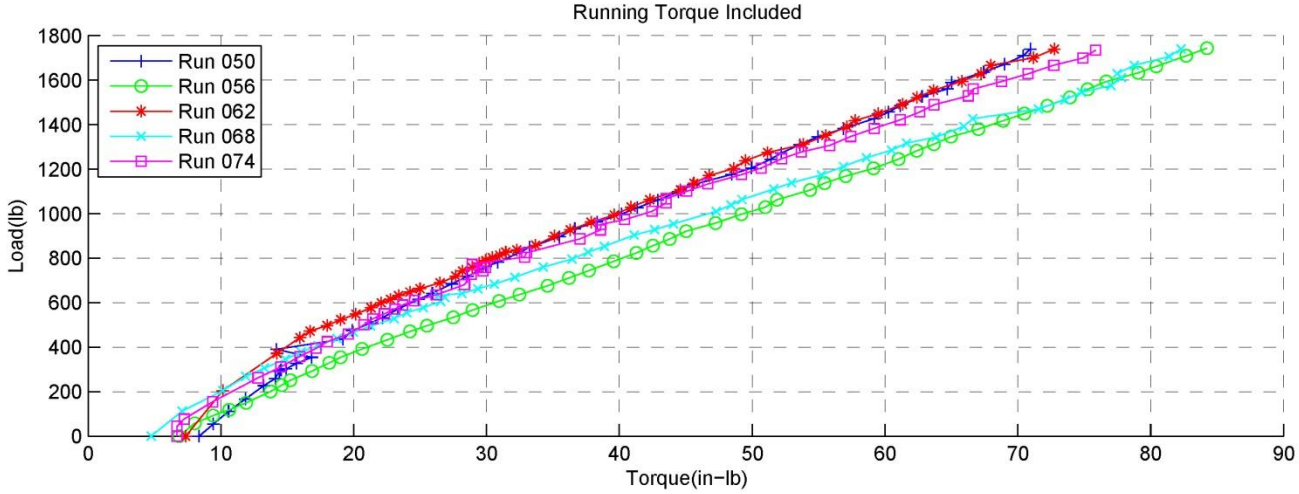

Torque vs. Load: Cycle No. 5
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Super Koropon : Insert = LD − MS51830CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 035
Run 041
Run 047
Load(lb)
Torque(in−lb)
Running Torque Included
Run 035
Run 041
Run 047
Load(lb)
Torque(in−lb)

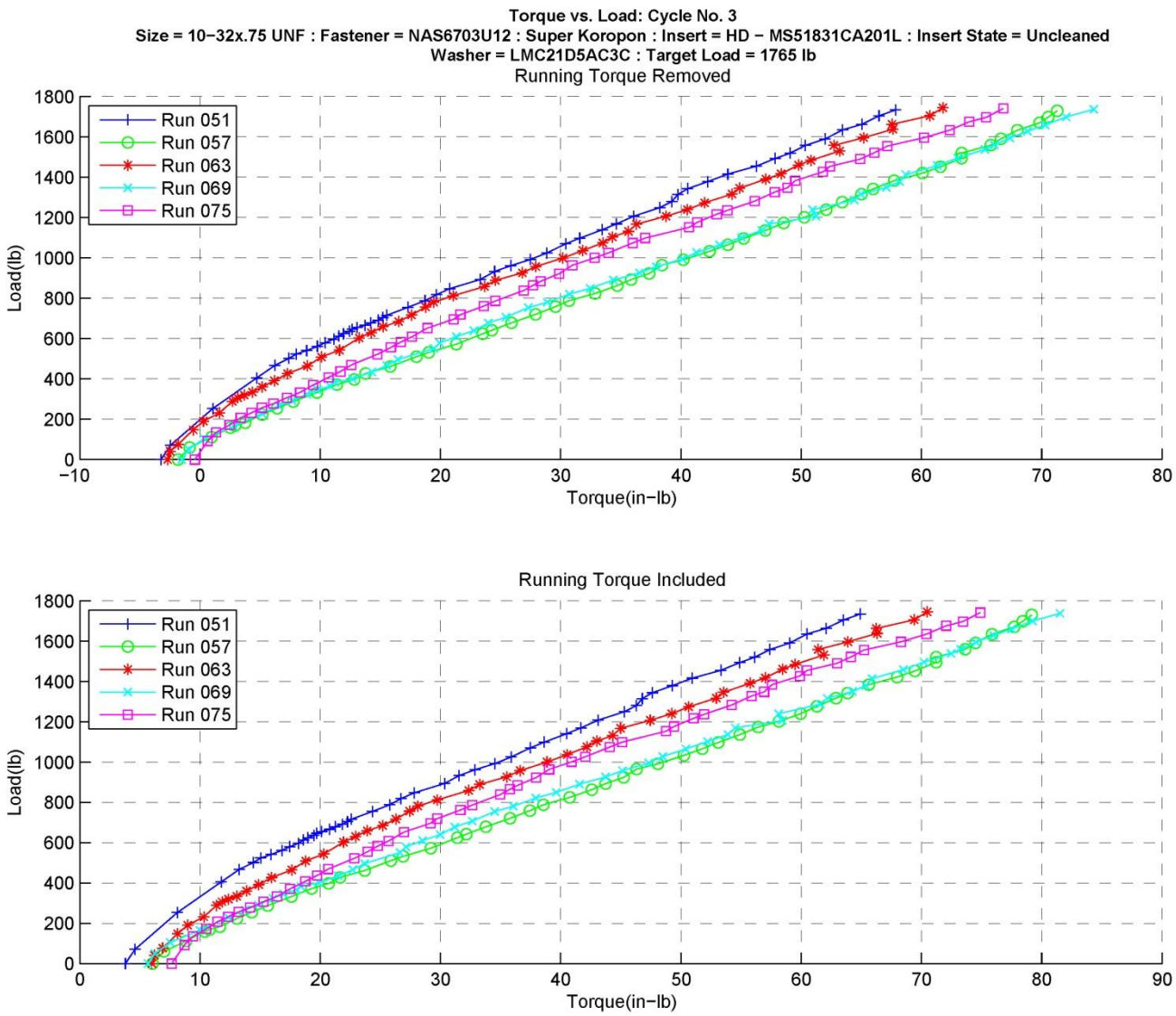

Torque vs. Load: Cycle No. 6
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Super Koropon : Insert = LD − MS51830CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 036
Run 042
Run 048
Load(lb)
Torque(in−lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
10
20
30
40
50
60
70

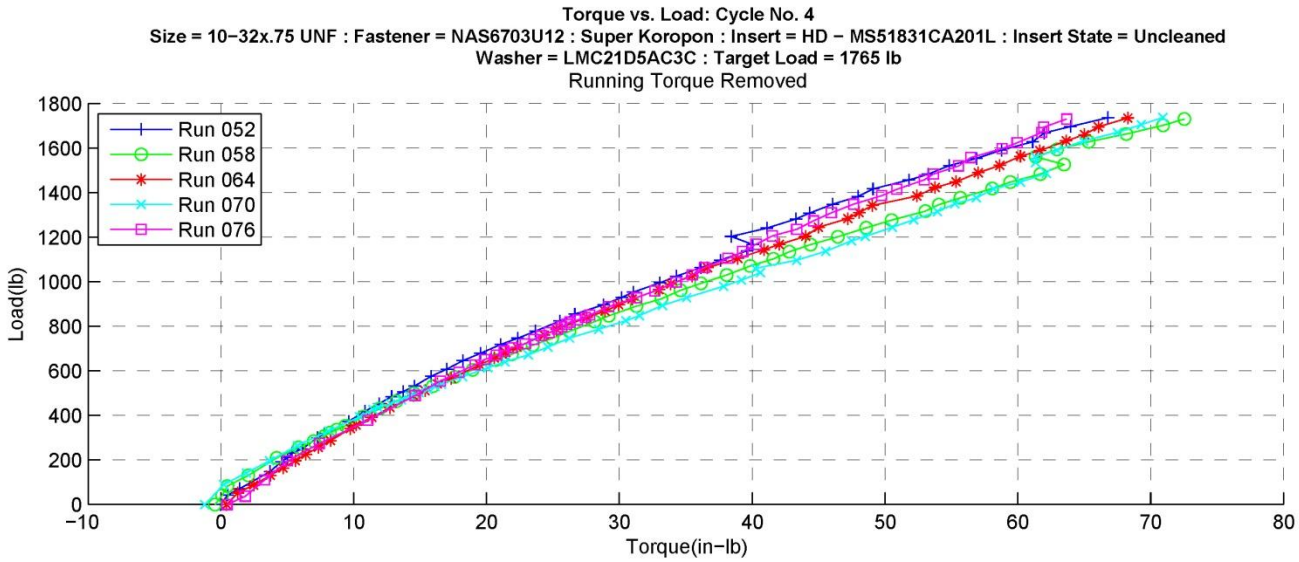

Running Torque Included
Run 036
Run 042
Run 048
Load(lb)
Torque(in−lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
10
20
30
40
50
60
70
80

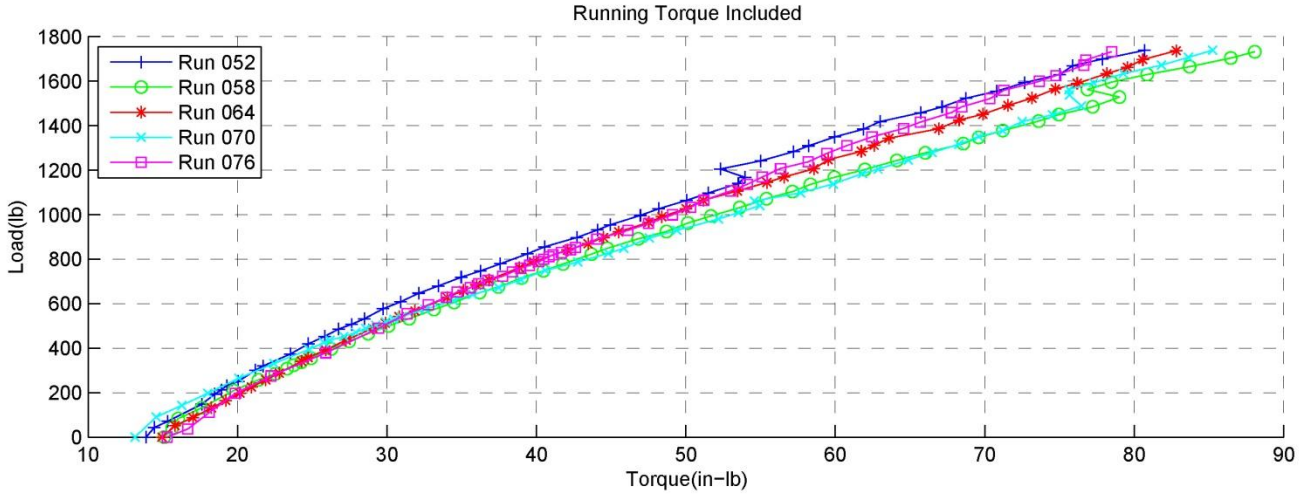

Torque vs. Load: Cycle No. 1
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Super Koropon : Insert = HD − MS51831CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 049
Run 055
Run 061
Run 067
Run 073
Load(lb)
Torque(in−lb)
Running Torque Included
Run 049
Run 055
Run 061
Run 067
Run 073
Load(lb)
Torque(in−lb)

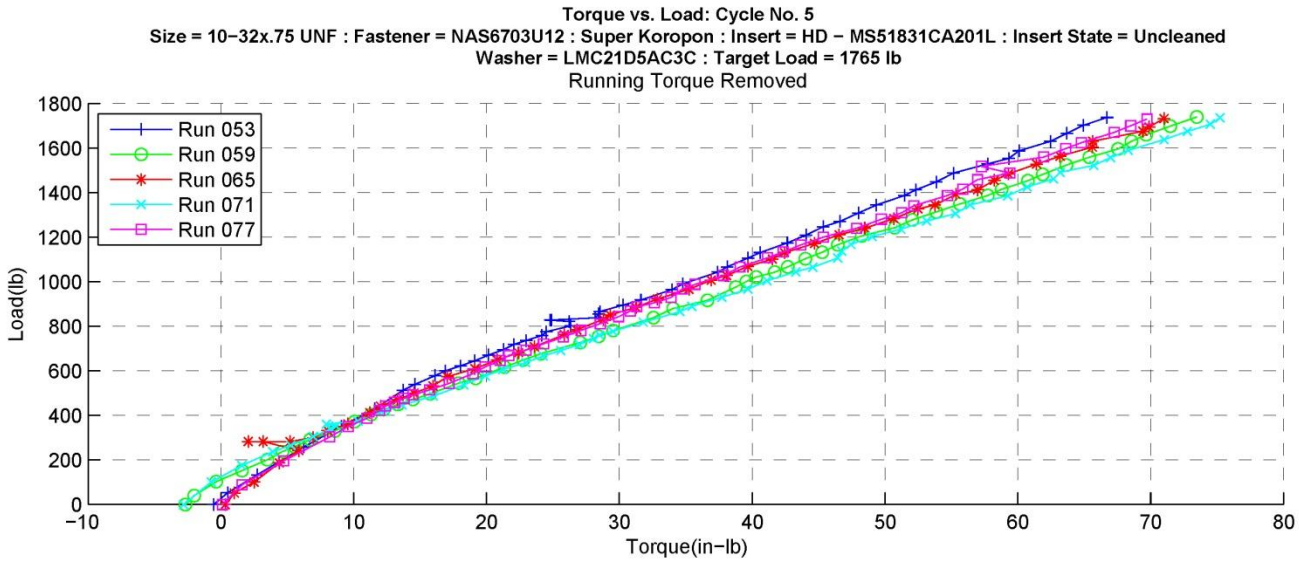

Torque vs. Load: Cycle No. 2
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Super Koropon : Insert = HD − MS51831CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 050
Run 056
Run 062
Run 068
Run 074
Load(lb)
Torque(in−lb)

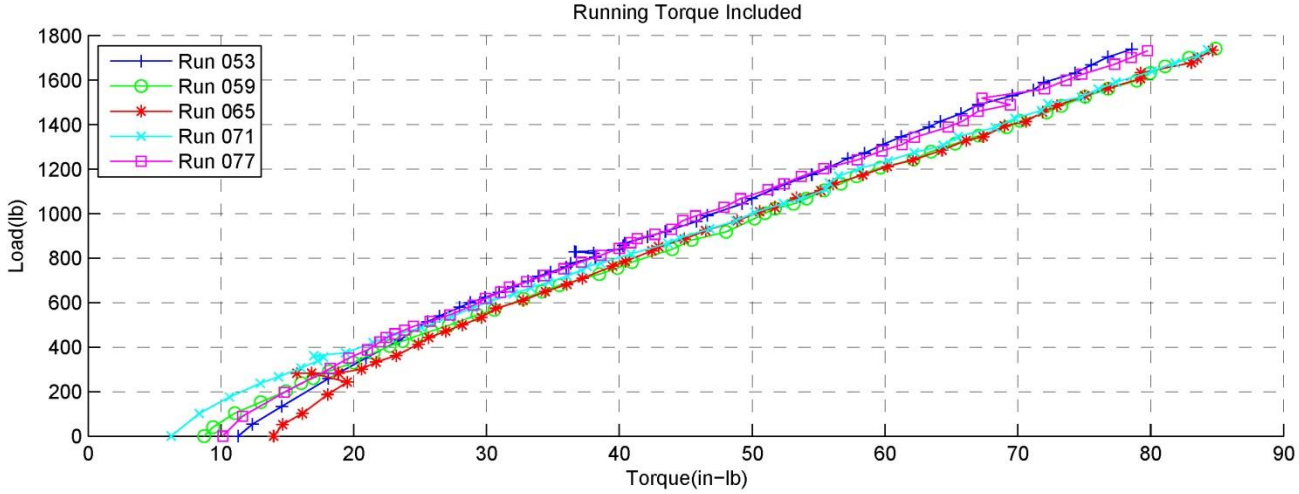

Running Torque Included
Run 050
Run 056
Run 062
Run 068
Run 074
Load(lb)
Torque(in−lb)

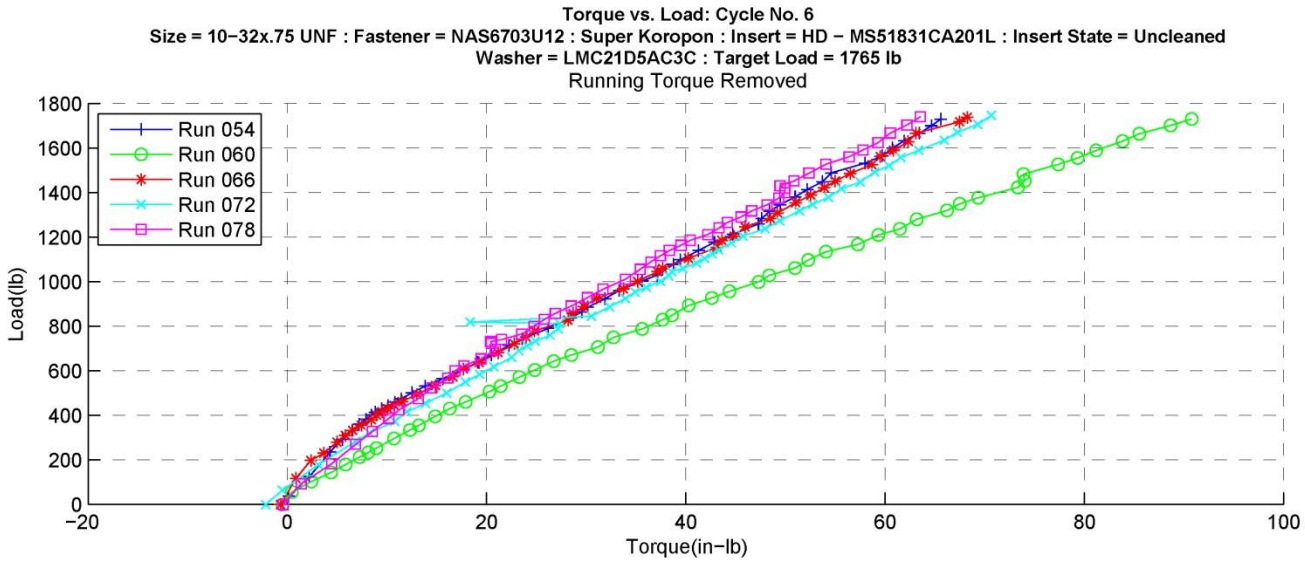

Torque vs. Load: Cycle No. 3
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Super Koropon : Insert = HD − MS51831CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 051
Run 057
Run 063
Run 069
Run 075
Load(lb)
Torque(in−lb)
Running Torque Included
Run 051
Run 057
Run 063
Run 069
Run 075
Load(lb)
Torque(in−lb)

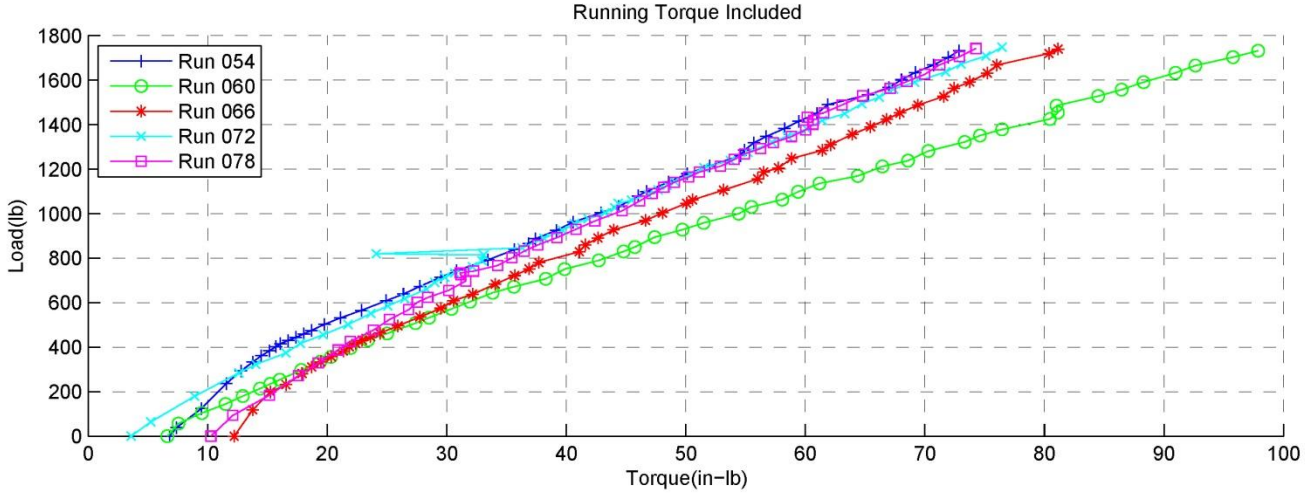

Torque vs. Load: Cycle No. 4
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Super Koropon : Insert = HD − MS51831CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 052
Run 058
Run 064
Run 070
Run 076
Load(lb)
Torque(in−lb)

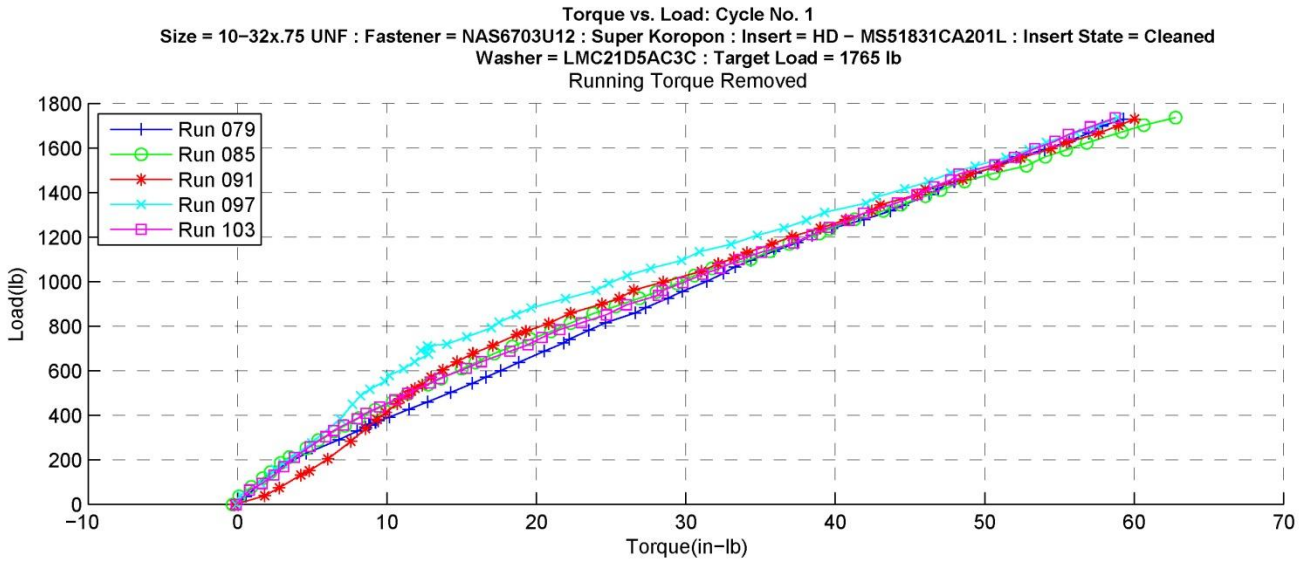

Running Torque Included
Run 052
Run 058
Run 064
Run 070
Run 076
Load(lb)
Torque(in−lb)

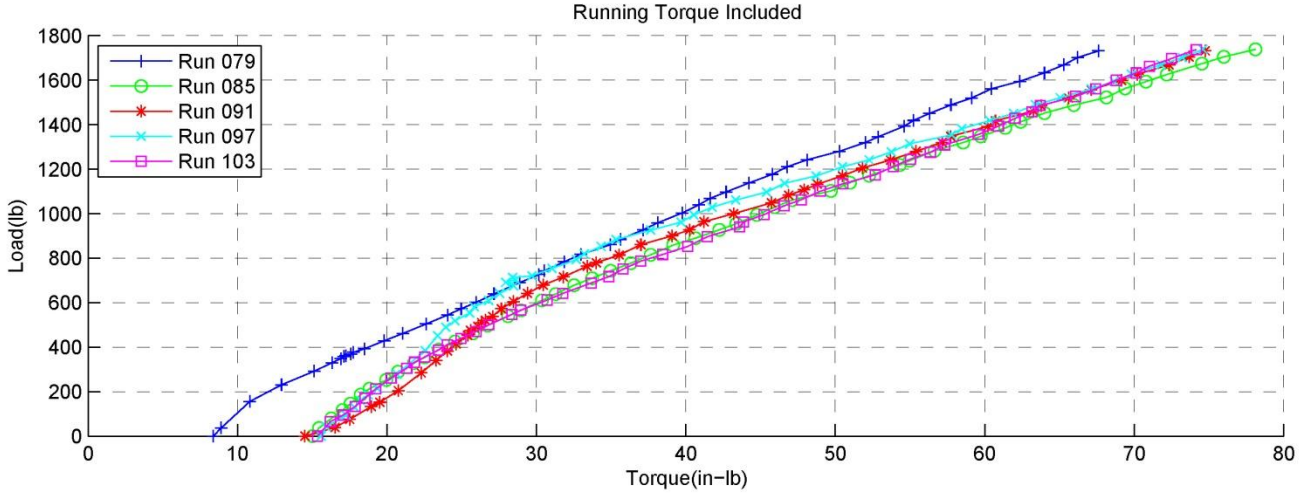

Torque vs. Load: Cycle No. 5
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Super Koropon : Insert = HD − MS51831CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 053
Run 059
Run 065
Run 071
Run 077
Load(lb)
Torque(in−lb)

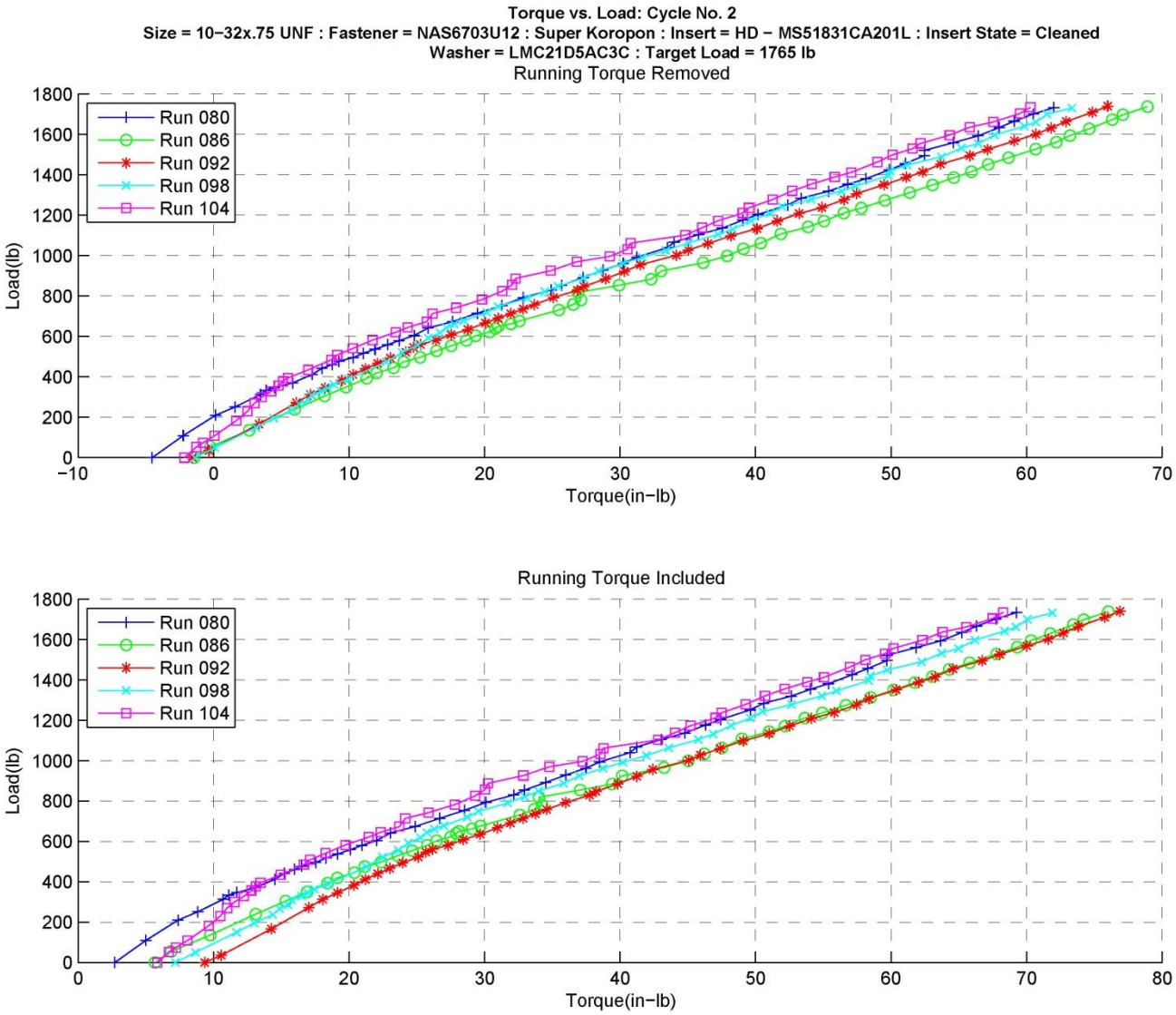

Running Torque Included
Run 053
Run 059
Run 065
Run 071
Run 077
Load(lb)
Torque(in−lb)

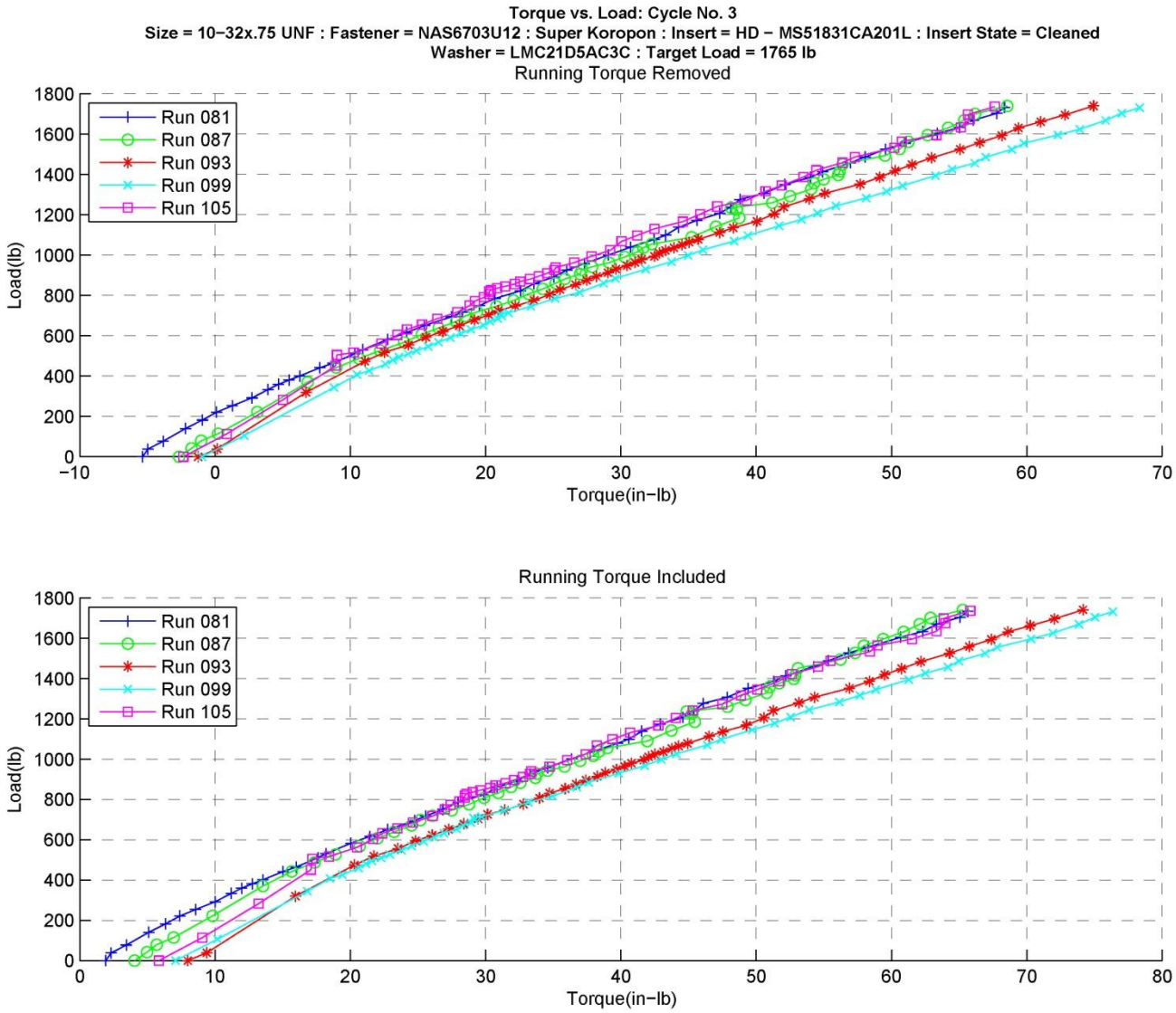

Torque vs. Load: Cycle No. 6
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Super Koropon : Insert = HD − MS51831CA201L : Insert State = Uncleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 054
Run 060
Run 066
Run 072
Run 078
Load(lb)
Torque(in−lb)

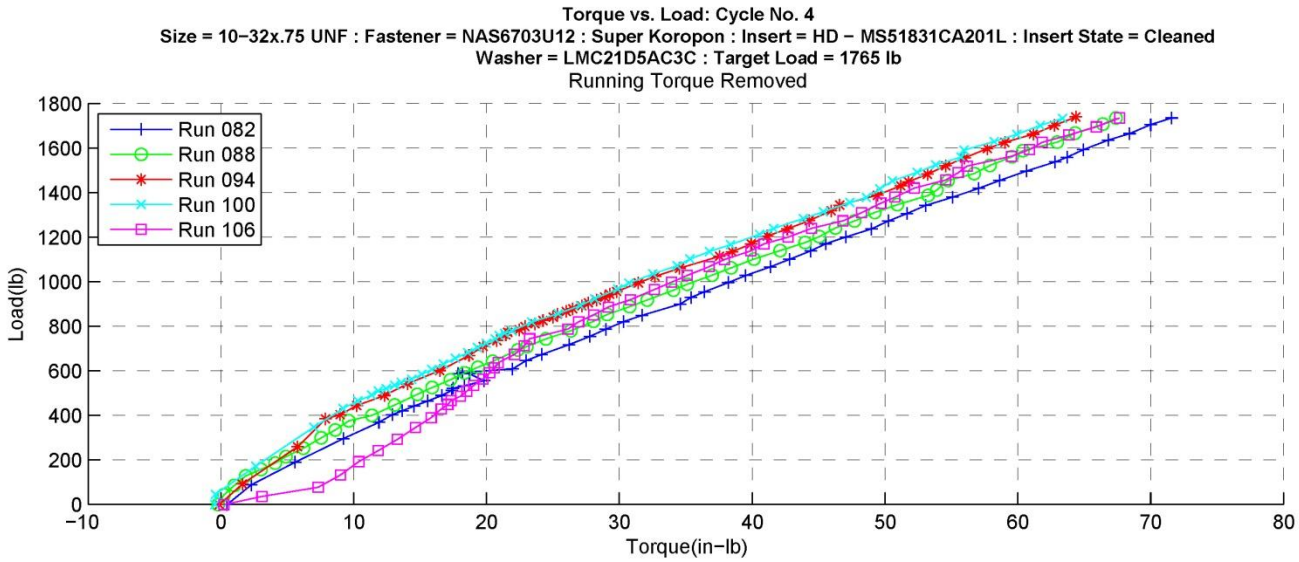

Running Torque Included
Run 054
Run 060
Run 066
Run 072
Run 078
Load(lb)
Torque(in−lb)

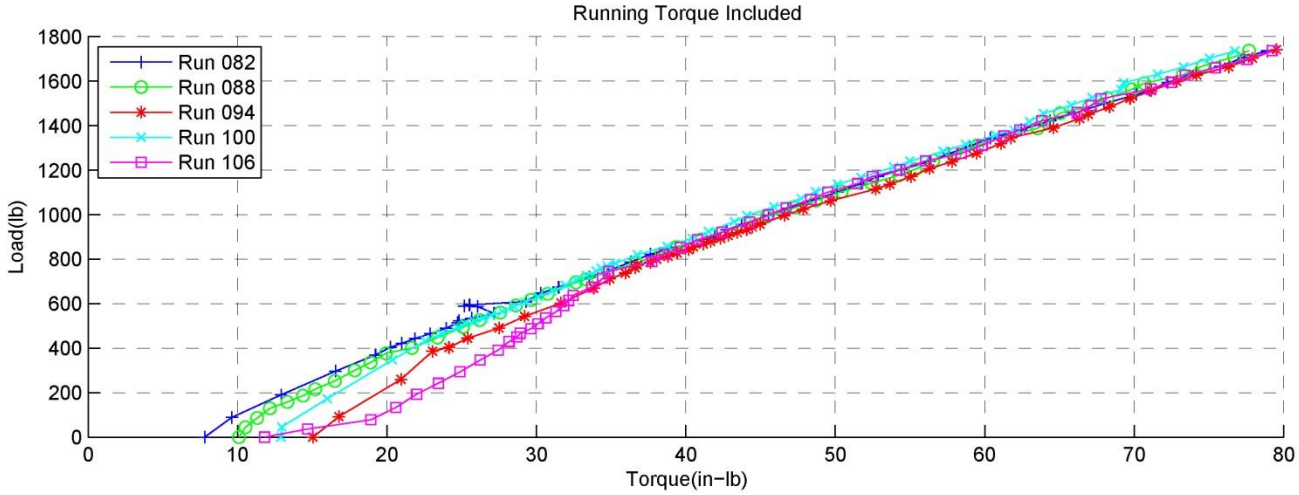

Torque vs. Load: Cycle No. 1
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Super Koropon : Insert = HD − MS51831CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 079
Run 085
Run 091
Run 097
Run 103
Load(lb)
Torque(in−lb)

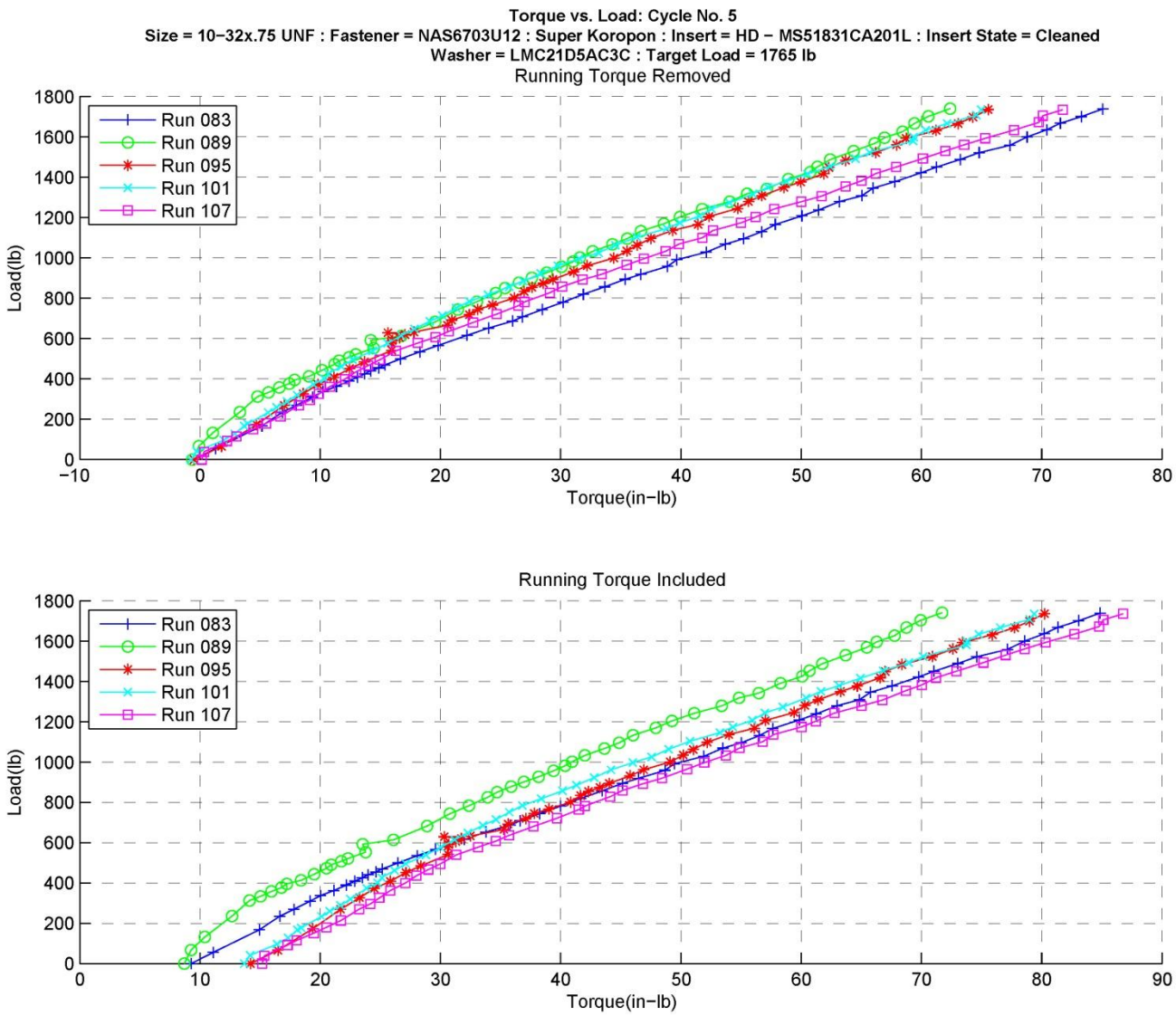

Running Torque Included
Run 079
Run 085
Run 091
Run 097
Run 103
Load(lb)
Torque(in−lb)

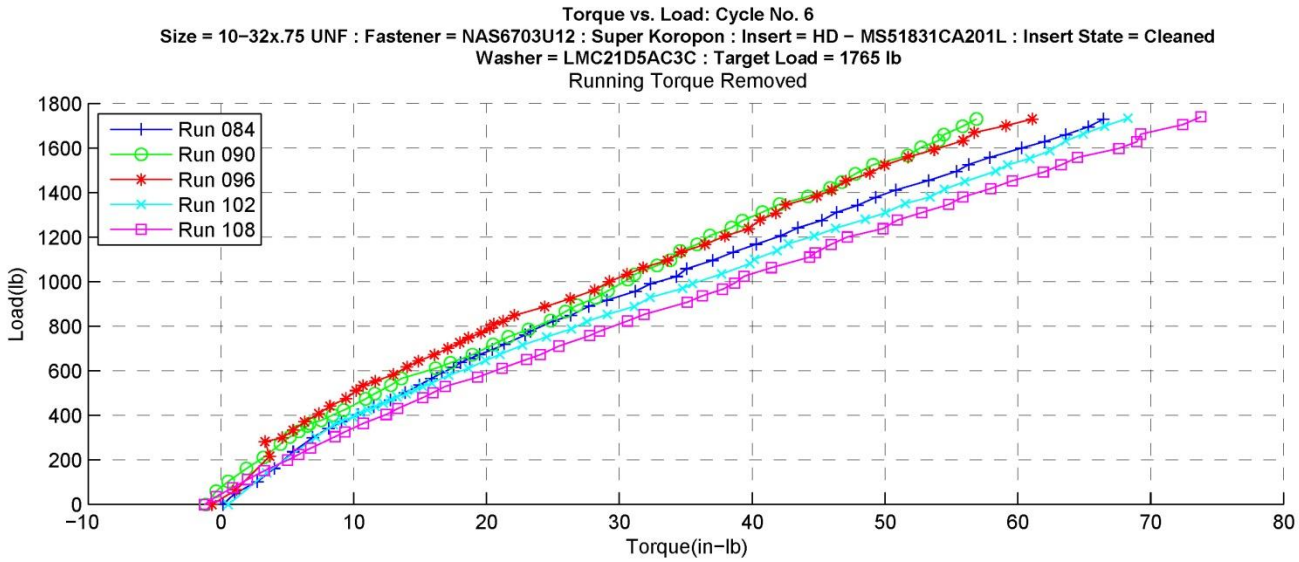

Torque vs. Load: Cycle No. 2
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Super Koropon : Insert = HD − MS51831CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 080
Run 086
Run 092
Run 098
Run 104
Load(lb)
Torque(in−lb)
Running Torque Included
Run 080
Run 086
Run 092
Run 098
Run 104
Load(lb)
Torque(in−lb)

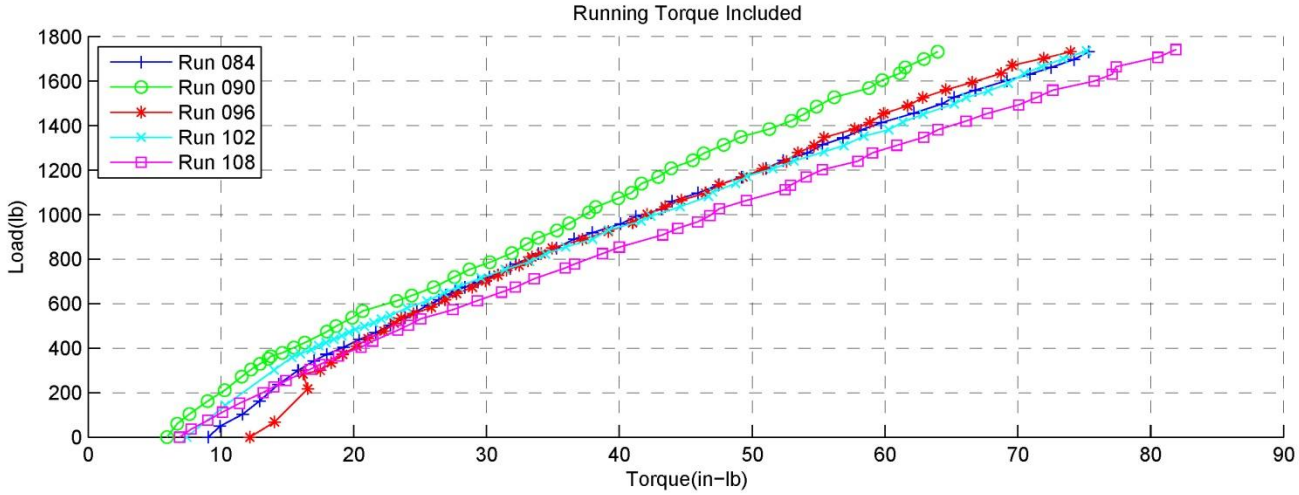

Torque vs. Load: Cycle No. 3
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Super Koropon : Insert = HD − MS51831CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 081
Run 087
Run 093
Run 099
Run 105
Load(lb)
Torque(in−lb)
Running Torque Included
Run 081
Run 087
Run 093
Run 099
Run 105
Load(lb)
Torque(in−lb)


Torque vs. Load: Cycle No. 4
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Super Koropon : Insert = HD − MS51831CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 082
Run 088
Run 094
Run 100
Run 106
Load(lb)
Torque(in−lb)


Running Torque Included
Run 082
Run 088
Run 094
Run 100
Run 106
Load(lb)
Torque(in−lb)


Torque vs. Load: Cycle No. 5
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Super Koropon : Insert = HD − MS51831CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 083
Run 089
Run 095
Run 101
Run 107
Load(lb)
Torque(in−lb)
Running Torque Included
Run 083
Run 089
Run 095
Run 101
Run 107
Load(lb)
Torque(in−lb)


Torque vs. Load: Cycle No. 6
Size = 10−32x.75 UNF : Fastener = NAS6703U12 : Super Koropon : Insert = HD − MS51831CA201L : Insert State = Cleaned
Washer = LMC21D5AC3C : Target Load = 1765 lb
Running Torque Removed
Run 084
Run 090
Run 096
Run 102
Run 108
Load(lb)
Torque(in−lb)


Running Torque Included
Run 084
Run 090
Run 096
Run 102
Run 108
Load(lb)
Torque(in−lb)

Appendix A:

Section 1	10-32 Dry Torque Tension Plots
Section 2	10-32 Wet Torque Tension Plots
Section 3	10-32 Dry Running Torque Plots
Section 4	10-32 Wet Running Torque Plots
Section 5	10-32 Dry Cycle Plots: Torque vs. Load
Section 6	10-32 Wet Cycle Plots: Torque vs. Load
Section 7	10-32 Friction Coefficients
Section 8	10-32 Test Plate Layouts
Section 9	10-32 Dry Run Logs
Section 10	10-32 Wet Run Logs

Table 1: Orion NESC Fastener Tests Summary - Individual DataSet Results

							Mean - Individual Cycles						Std Dev - Individual Cycles					
Set	Fastener	Lubrication	Insert	Insert State	N	90%	1	2	3	4	5	6	1	2	3	4	5	6
8	#10-32	None	ExHD	Unclean	5	3.407	0.164	0.239	0.289	0.280	0.224	0.241	0.100	0.035	0.026	0.113	0.132	0.139
9	#10-32	None	ExHD	Clean	4	4.162	0.212	0.280	0.335	0.242	0.283	0.329	0.016	0.021	0.023	0.025	0.037	0.029
10	#10-32	None	HD	Clean	5	3.407	0.195	0.227	0.281	0.205	0.263	0.319	0.027	0.037	0.058	0.008	0.012	0.019
11	#10-32	Super Koropon	LD	Unclean	5	3.407	0.187	0.182	0.175	0.183	0.189	0.181	0.010	0.016	0.018	0.011	0.009	0.004
12	#10-32	Super Koropon	LD	Clean	3	6.155	0.179	0.166	0.154	0.225	0.208	0.196	0.009	0.001	0.011	0.015	0.022	0.009
13	#10-32	Super Koropon	HD	Unclean	5	3.407	0.192	0.207	0.201	0.208	0.216	0.217	0.017	0.019	0.021	0.011	0.010	0.034
14	#10-32	Super Koropon	HD	Clean	5	3.407	0.182	0.195	0.187	0.203	0.206	0.198	0.005	0.010	0.015	0.010	0.016	0.019

Table 2: Orion NESC Fastener Tests Summary - DataSet Grouping No. 1

					Individual Cycle Results														Combined Cycle Results			
							Mean							Standard Deviation									
Set	Fastener	Lubrication	Insert	Insert State	N	90%	1	2	3	4	5	6	1	2	3	4	5	6	N	90%	Mean	StdDev
8+9	#10-32	None	ExHD	Unclean+Clean	9	2.454	0.186	0.257	0.310	0.263	0.250	0.280	0.076	0.035	0.033	0.084	0.101	0.110	54	1.646	0.258	0.084
11+12	#10-32	Super Koropon	LD	Unclean+Clean	8	2.582	0.184	0.176	0.167	0.199	0.197	0.187	0.010	0.015	0.019	0.025	0.017	0.009	48	1.654	0.185	0.019
13+14	#10-32	Super Koropon	HD	Unclean+Clean	10	2.355	0.187	0.201	0.194	0.205	0.211	0.208	0.013	0.015	0.019	0.010	0.014	0.028	60	1.646	0.201	0.019

Table 3: Orion NESC Fastener Tests Summary - DataSet Grouping No. 2

					Individual Cycle Results														Combined Cycle Results			
							Mean							Standard Deviation									
Set	Fastener	Lubrication	Inserts	Insert State	N	90%	1	2	3	4	5	6	1	2	3	4	5	6	N	90%	Mean	StdDev
8+9+10	#10-32	None	ExHD+HD	Unclean+Clean	14	2.109	0.189	0.247	0.300	0.243	0.255	0.294	0.062	0.037	0.044	0.072	0.080	0.089	84	1.646	0.254	0.074
11+12+13+14	#10-32	Super Koropon	LD+HD	Unclean+Clean	18	1.974	0.185	0.189	0.182	0.202	0.205	0.198	0.011	0.019	0.023	0.018	0.016	0.024	108	1.646	0.194	0.020

Orion NESC Fastener Tests: Individual Friction Results

Table 4: ORION TEST RESULTS FOR 10-32x.75 UNF NAS6703U12 FASTENERS (160KSI

(Lubrication: No Lube, Hardware: Uncleaned)

TEST RUN	TEST CYCLES INTO LOCKING ExHD - MS51832CA201L KEENSERTS						INSERT
NUMBER	1	2	3	4	5	6	NUMBER
1	0.000	0.262	0.315	0.256	0.324	0.326	1
7	0.181	0.217	0.261	0.206	0.225	0.242	2
13	0.186	0.204	0.292	0.227	0.253	0.314	3
19	0.274	0.289	0.314	0.479	0.000	0.000	4
23	0.181	0.225	0.264	0.231	0.315	0.320	5

0.822	1.197	1.447	1.399	1.118	1.203	SUM
0.206	0.239	0.289	0.280	0.279	0.301	MEAN
0.184	0.225	0.292	0.231	0.284	0.317	MEDIAN
0.046	0.035	0.026	0.113	0.048	0.039	STDVA

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL

(With 95% Confidence for 90% of population)

(N = 5 : 90% = 3.407)

0.361293	0.358649	0.378823	0.664511	0.442795	0.434417	Kmax-90%
0.049707	0.120210	0.199967	-0.104851	0.115705	0.166583	Kmin-90%

Orion NESC Fastener Tests: Individual Friction Results

Table 5: ORION TEST RESULTS FOR 10-32x.75 UNF NAS6703U12 FASTENERS (160KSI

(Lubrication: No Lube, Hardware: Cleaned)

TEST RUN	TEST CYCLES INTO LOCKING ExHD - MS51832CA201L KEENSERTS						INSERT
NUMBER	1	2	3	4	5	6	NUMBER
59	0.198	0.273	0.335	0.226	0.284	0.344	1
65	0.202	0.255	0.304	0.225	0.247	0.287	2
71	0.215	0.290	0.347	0.240	0.269	0.353	3
77	0.234	0.303	0.355	0.278	0.334	0.333	4

0.850	1.120	1.341	0.969	1.134	1.317	SUM
0.212	0.280	0.335	0.242	0.283	0.329	MEAN
0.209	0.281	0.341	0.233	0.277	0.339	MEDIAN
0.016	0.021	0.023	0.025	0.037	0.029	STDVA

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL

(With 95% Confidence for 90% of population)

(N = 4 : 90% = 4.162)

0.280545	0.366874	0.429083	0.344362	0.437198	0.45193	Kmax-90%
0.144246	0.193243	0.241665	0.140208	0.129797	0.206509	Kmin-90%

Orion NESC Fastener Tests: Individual Friction Results

Table 6: ORION TEST RESULTS FOR 10-32x.75 UNF NAS6703U12 FASTENERS (160KSI

(Lubrication: No Lube, Hardware: Cleaned)

TEST RUN	TEST CYCLES INTO LOCKING HD - MS51831CA201L KEENSERTS						INSERT
NUMBER	1	2	3	4	5	6	NUMBER
29	0.165	0.175	0.196	0.200	0.257	0.334	1
35	0.181	0.213	0.256	0.197	0.270	0.304	2
41	0.205	0.257	0.328	0.206	0.276	0.337	3
47	0.235	0.267	0.337	0.217	0.245	0.294	4
53	0.188	0.225	0.288	0.207	0.266	0.325	5

0.974	1.137	1.405	1.027	1.314	1.594	SUM
0.195	0.227	0.281	0.205	0.263	0.319	MEAN
0.188	0.225	0.288	0.206	0.266	0.325	MEDIAN
0.027	0.037	0.058	0.008	0.012	0.019	STDVA

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL

(With 95% Confidence for 90% of population)

(N = 5 : 90% = 3.407)

0.286403	0.352541	0.477309	0.232247	0.303955	0.383318	Kmax-90%
0.103323	0.102132	0.084755	0.178704	0.221559	0.254155	Kmin-90%

Orion NESC Fastener Tests: Individual Friction Results

Table 7: ORION TEST RESULTS FOR 10-32x.75 UNF NAS6703U12 FASTENERS (160KSI

(Lubrication: Super Koropon, Hardware: Uncleaned)

TEST RUN NUMBER	TEST CYCLES INTO LOCKING LD - MS51830CA201L KEENSERTS						INSERT NUMBER
	1	2	3	4	5	6	
1	0.179	0.204	0.190	0.169	0.187	0.184	1
7	0.193	0.167	0.151	0.174	0.188	0.183	2
13	0.201	0.192	0.194	0.186	0.203	0.185	3
19	0.177	0.171	0.177	0.186	0.177	0.177	4
25	0.185	0.174	0.164	0.199	0.191	0.177	5
	0.934	0.908	0.875	0.915	0.947	0.905	SUM
	0.187	0.182	0.175	0.183	0.189	0.181	MEAN
	0.185	0.174	0.177	0.186	0.188	0.183	MEDIAN
	0.010	0.016	0.018	0.011	0.009	0.004	STDVA

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL

(With 95% Confidence for 90% of population)

(N = 5 : 90% = 3.407)

0.220163	0.235796	0.237255	0.222016	0.221375	0.194909	Kmax-90%
0.153572	0.127455	0.112942	0.143927	0.157555	0.167241	Kmin-90%

Orion NESC Fastener Tests: Individual Friction Results

Table 8: ORION TEST RESULTS FOR 10-32x.75 UNF NAS6703U12 FASTENERS (160KSI

(Lubrication: Super Koropon, Hardware: Cleaned)

TEST RUN	TEST CYCLES INTO LOCKING LD - MS51830CA201L KEENSERTS						INSERT
NUMBER	1	2	3	4	5	6	NUMBER
31	0.172	0.165	0.155	0.242	0.184	0.205	1
37	0.189	0.167	0.165	0.223	0.229	0.189	2
43	0.175	0.165	0.142	0.212	0.211	0.192	3

0.536	0.497	0.462	0.676	0.625	0.587	SUM
0.179	0.166	0.154	0.225	0.208	0.196	MEAN
0.175	0.165	0.155	0.223	0.211	0.192	MEDIAN
0.009	0.001	0.011	0.015	0.022	0.009	STDVA

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL

(With 95% Confidence for 90% of population)

(N = 3 : 90% = 6.155)

0.232391	0.171367	0.222693	0.317952	0.345906	0.248049	Kmax-90%
0.124923	0.159922	0.08533	0.132953	0.070575	0.143101	Kmin-90%

Orion NESC Fastener Tests: Individual Friction Results

Table 9: ORION TEST RESULTS FOR 10-32x.75 UNF NAS6703U12 FASTENERS (160KSI

(Lubrication: Super Koropon, Hardware: Uncleaned)

TEST RUN	TEST CYCLES INTO LOCKING HD - MS51831CA201L KEENSERTS						INSERT
NUMBER	1	2	3	4	5	6	NUMBER
49	0.170	0.184	0.176	0.202	0.202	0.199	1
55	0.210	0.225	0.217	0.221	0.222	0.276	2
61	0.187	0.191	0.186	0.207	0.216	0.207	3
67	0.207	0.224	0.225	0.215	0.228	0.213	4
73	0.185	0.208	0.202	0.194	0.212	0.192	5

0.959	1.033	1.006	1.038	1.080	1.087	SUM
0.192	0.207	0.201	0.208	0.216	0.217	MEAN
0.187	0.208	0.202	0.207	0.216	0.207	MEDIAN
0.017	0.019	0.021	0.011	0.010	0.034	STDVA

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL
(With 95% Confidence for 90% of population)
(N = 5 : 90% = 3.407)

0.248353	0.269729	0.271434	0.243524	0.249817	0.332164	Kmax-90%
0.135158	0.143293	0.130973	0.171796	0.18216	0.10268	Kmin-90%

Orion NESC Fastener Tests: Individual Friction Results

Table 10: ORION TEST RESULTS FOR 10-32x.75 UNF NAS6703U12 FASTENERS (160KSI

(Lubrication: Super Koropon, Hardware: Cleaned)

TEST RUN	TEST CYCLES INTO LOCKING HD - MS51831CA201L KEENSERTS						INSERT
NUMBER	1	2	3	4	5	6	NUMBER
79	0.18	0.188	0.177	0.217	0.227	0.202	1
85	0.19	0.209	0.177	0.204	0.189	0.173	2
91	0.183	0.2	0.196	0.195	0.199	0.186	3
97	0.179	0.193	0.208	0.192	0.197	0.207	4
103	0.178	0.183	0.175	0.205	0.218	0.223	5

0.91	0.973	0.933	1.014	1.029	0.991	SUM
0.182	0.195	0.187	0.203	0.206	0.198	MEAN
0.18	0.193	0.177	0.204	0.199	0.202	MEDIAN
0.005	0.01	0.015	0.01	0.016	0.019	STDVA

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL

(With 95% Confidence for 90% of population)

(N = 5 : 90% = 3.407)

0.198861	0.228865	0.236823	0.236179	0.260374	0.26436	Kmax-90%
0.164986	0.160159	0.136573	0.169236	0.15142	0.132033	Kmin-90%

Orion NESC Fastener Tests: DataSet Grouping No. 1 Friction Results

Table 11: ORION TEST RESULTS FOR 10-32x.75 UNF NAS6703U12 FASTENERS (160KSI)

(Lubrication: No Lube)

TEST RUN NUMBER	TEST CYCLES INTO LOCKING KEENSERTS 1	2	3	4	5	6	INSERT TYPE	INSERT STATE
1	0.000	0.262	0.315	0.256	0.324	0.326	ExHD - MS51832CA201L	Uncleaned
7	0.181	0.217	0.261	0.206	0.225	0.242	ExHD - MS51832CA201L	Uncleaned
13	0.186	0.204	0.292	0.227	0.253	0.314	ExHD - MS51832CA201L	Uncleaned
19	0.274	0.289	0.314	0.479	0.000	0.000	ExHD - MS51832CA201L	Uncleaned
23	0.181	0.225	0.264	0.231	0.315	0.320	ExHD - MS51832CA201L	Uncleaned
59	0.198	0.273	0.335	0.226	0.284	0.344	ExHD - MS51832CA201L	Cleaned
65	0.202	0.255	0.304	0.225	0.247	0.287	ExHD - MS51832CA201L	Cleaned
71	0.215	0.290	0.347	0.240	0.269	0.353	ExHD - MS51832CA201L	Cleaned
77	0.234	0.303	0.355	0.278	0.334	0.333	ExHD - MS51832CA201L	Cleaned

STATISTICAL RESULTS FOR INDIVIDUAL CYCLES

1.671	2.317	2.788	2.368	2.252	2.519	SUM
0.209	0.257	0.310	0.263	0.281	0.315	MEAN
0.200	0.262	0.314	0.231	0.277	0.323	MEDIAN
0.032	0.035	0.033	0.084	0.040	0.036	STDVA

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL
(With 95% Confidence for 90% of population)
(N = 9 : 90% = 2.454)

0.287320	0.343689	0.392024	0.468333	0.378840	0.402224	Kmax-90%
0.130430	0.171284	0.227637	0.057954	0.183910	0.227526	Kmin-90%

STATISTICAL RESULTS FOR COMBINED CYCLES

Sum	13.915
Mean	0.273
Median	0.269
Standard Deviation	0.057

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL
(With 95% Confidence for 90% of population)
(N = 54 : 90% = 1.646)

Kmax-90%	0.366903
Kmin-90%	0.178139

Orion NESC Fastener Tests: DataSet Grouping No. 1 Friction Results

Table 12: ORION TEST RESULTS FOR 10-32x.75 UNF NAS6703U12 FASTENERS (160KSI)

(Lubrication: Super Koropon)

TEST RUN NUMBER	TEST CYCLES INTO LOCKING KEENSERTS 1	2	3	4	5	6	INSERT TYPE	INSERT STATE
1	0.179	0.204	0.190	0.169	0.187	0.184	LD - MS51830CA201L	Uncleaned
7	0.193	0.167	0.151	0.174	0.188	0.183	LD - MS51830CA201L	Uncleaned
13	0.201	0.192	0.194	0.186	0.203	0.185	LD - MS51830CA201L	Uncleaned
19	0.177	0.171	0.177	0.186	0.177	0.177	LD - MS51830CA201L	Uncleaned
25	0.185	0.174	0.164	0.199	0.191	0.177	LD - MS51830CA201L	Uncleaned
31	0.172	0.165	0.155	0.242	0.184	0.205	LD - MS51830CA201L	Cleaned
37	0.189	0.167	0.165	0.223	0.229	0.189	LD - MS51830CA201L	Cleaned
43	0.175	0.165	0.142	0.212	0.211	0.192	LD - MS51830CA201L	Cleaned

STATISTICAL RESULTS FOR INDIVIDUAL CYCLES

1.470	1.405	1.338	1.591	1.572	1.492	SUM
0.184	0.176	0.167	0.199	0.197	0.187	MEAN
0.182	0.169	0.164	0.192	0.190	0.184	MEDIAN
0.010	0.015	0.019	0.025	0.017	0.009	STDVA

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL
(With 95% Confidence for 90% of population)
(N = 8 : 90% = 2.582)

0.208876	0.213326	0.215141	0.263346	0.240284	0.210527	Kmax-90%
0.158701	0.137939	0.119241	0.134458	0.152728	0.162498	Kmin-90%

STATISTICAL RESULTS FOR COMBINED CYCLES

Sum	8.868
Mean	0.185
Median	0.185
Standard Deviation	0.019

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL
(With 95% Confidence for 90% of population)
(N = 48 : 90% = 1.654)

Kmax-90%	0.216595
Kmin-90%	0.152915

Orion NESC Fastener Tests: DataSet Grouping No. 1 Friction Results

Table 13: ORION TEST RESULTS FOR 10-32x.75 UNF NAS6703U12 FASTENERS (160KSI)

(Lubrication: Super Koropon)

TEST RUN NUMBER	TEST CYCLES INTO LOCKING KEENSERTS 1	2	3	4	5	6	INSERT TYPE	INSERT STATE
49	0.170	0.184	0.176	0.202	0.202	0.199	HD - MS51831CA201L	Uncleaned
55	0.210	0.225	0.217	0.221	0.222	0.276	HD - MS51831CA201L	Uncleaned
61	0.187	0.191	0.186	0.207	0.216	0.207	HD - MS51831CA201L	Uncleaned
67	0.207	0.224	0.225	0.215	0.228	0.213	HD - MS51831CA201L	Uncleaned
73	0.185	0.208	0.202	0.194	0.212	0.192	HD - MS51831CA201L	Uncleaned
79	0.180	0.188	0.177	0.217	0.227	0.202	HD - MS51831CA201L	Cleaned
85	0.190	0.209	0.177	0.204	0.189	0.173	HD - MS51831CA201L	Cleaned
91	0.183	0.200	0.196	0.195	0.199	0.186	HD - MS51831CA201L	Cleaned
97	0.179	0.193	0.208	0.192	0.197	0.207	HD - MS51831CA201L	Cleaned
103	0.178	0.183	0.175	0.205	0.218	0.223	HD - MS51831CA201L	Cleaned

STATISTICAL RESULTS FOR INDIVIDUAL CYCLES

1.868	2.005	1.940	2.052	2.109	2.078	SUM
0.187	0.201	0.194	0.205	0.211	0.208	MEAN
0.184	0.196	0.191	0.205	0.214	0.204	MEDIAN
0.013	0.015	0.019	0.010	0.014	0.028	STDVA

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL
(With 95% Confidence for 90% of population)
(N = 10 : 90% = 2.355)

0.216673	0.236858	0.237598	0.228611	0.243038	0.273344	Kmax-90%
0.157006	0.164165	0.150304	0.181757	0.178848	0.142274	Kmin-90%

STATISTICAL RESULTS FOR COMBINED CYCLES

Sum	12.052
Mean	0.201
Median	0.201
Standard Deviation	0.019

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL
(With 95% Confidence for 90% of population)
(N = 60 : 90% = 1.646)

Kmax-90%	0.231436
Kmin-90%	0.170309

Orion NESC Fastener Tests: Friction Results

Table 14: ORION TEST RESULTS FOR 10-32x.75 UNF NAS6703U12 FASTENERS (160KSI)
(Lubrication: No Lube)

TEST RUN	TEST CYCLES INTO LOCKING KEENSERTS						INSERT	INSERT
NUMBER	1	2	3	4	5	6	TYPE	STATE
1	0.000	0.262	0.315	0.256	0.324	0.326	ExHD - MS51832CA201L	Uncleaned
7	0.181	0.217	0.261	0.206	0.225	0.242	ExHD - MS51832CA201L	Uncleaned
13	0.186	0.204	0.292	0.227	0.253	0.314	ExHD - MS51832CA201L	Uncleaned
19	0.274	0.289	0.314	0.479	0.000	0.000	ExHD - MS51832CA201L	Uncleaned
23	0.181	0.225	0.264	0.231	0.315	0.320	ExHD - MS51832CA201L	Uncleaned
59	0.198	0.273	0.335	0.226	0.284	0.344	ExHD - MS51832CA201L	Cleaned
65	0.202	0.255	0.304	0.225	0.247	0.287	ExHD - MS51832CA201L	Cleaned
71	0.215	0.290	0.347	0.240	0.269	0.353	ExHD - MS51832CA201L	Cleaned
77	0.234	0.303	0.355	0.278	0.334	0.333	ExHD - MS51832CA201L	Cleaned
29	0.165	0.175	0.196	0.200	0.257	0.334	HD - MS51831CA201L	Cleaned
35	0.181	0.213	0.256	0.197	0.270	0.304	HD - MS51831CA201L	Cleaned
41	0.205	0.257	0.328	0.206	0.276	0.337	HD - MS51831CA201L	Cleaned
47	0.235	0.267	0.337	0.217	0.245	0.294	HD - MS51831CA201L	Cleaned
53	0.188	0.225	0.288	0.207	0.266	0.325	HD - MS51831CA201L	Cleaned

STATISTICAL RESULTS FOR INDIVIDUAL CYCLES

2.646	3.454	4.194	3.396	3.566	4.113	SUM
0.203	0.247	0.300	0.243	0.274	0.316	MEAN
0.198	0.256	0.309	0.226	0.269	0.325	MEDIAN
0.030	0.037	0.044	0.072	0.033	0.029	STDVA

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL
(With 95% Confidence for 90% of population)
(N = 14 : 90% = 2.109)

0.266164	0.32562	0.391876	0.393803	0.342815	0.378326	Kmax-90%
0.140759	0.167818	0.207215	0.091292	0.205647	0.254444	Kmin-90%

STATISTICAL RESULTS FOR COMBINED CYCLES

Sum	21.369
Mean	0.264
Median	0.263
Standard Deviation	0.057

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL
(With 95% Confidence for 90% of population)
(N = 84 : 90% = 1.646)

Kmax-90%	0.357196
Kmin-90%	0.170830

Orion NESC Fastener Tests: Friction Results

Table 15: ORION TEST RESULTS FOR 10-32x.75 UNF NAS6703U12 FASTENERS (160KSI)
(Lubrication: Super Koropon)

TEST RUN	TEST CYCLES INTO LOCKING KEENSERTS						INSERT	INSERT
NUMBER	1	2	3	4	5	6	TYPE	STATE
1	0.179	0.204	0.190	0.169	0.187	0.184	LD - MS51830CA201L	Uncleaned
7	0.193	0.167	0.151	0.174	0.188	0.183	LD - MS51830CA201L	Uncleaned
13	0.201	0.192	0.194	0.186	0.203	0.185	LD - MS51830CA201L	Uncleaned
19	0.177	0.171	0.177	0.186	0.177	0.177	LD - MS51830CA201L	Uncleaned
25	0.185	0.174	0.164	0.199	0.191	0.177	LD - MS51830CA201L	Uncleaned
31	0.172	0.165	0.155	0.242	0.184	0.205	LD - MS51830CA201L	Cleaned
37	0.189	0.167	0.165	0.223	0.229	0.189	LD - MS51830CA201L	Cleaned
43	0.175	0.165	0.142	0.212	0.211	0.192	LD - MS51830CA201L	Cleaned
49	0.170	0.184	0.176	0.202	0.202	0.199	HD - MS51831CA201L	Uncleaned
55	0.210	0.225	0.217	0.221	0.222	0.276	HD - MS51831CA201L	Uncleaned
61	0.187	0.191	0.186	0.207	0.216	0.207	HD - MS51831CA201L	Uncleaned
67	0.207	0.224	0.225	0.215	0.228	0.213	HD - MS51831CA201L	Uncleaned
73	0.185	0.208	0.202	0.194	0.212	0.192	HD - MS51831CA201L	Uncleaned
79	0.180	0.188	0.177	0.217	0.227	0.202	HD - MS51831CA201L	Cleaned
85	0.190	0.209	0.177	0.204	0.189	0.173	HD - MS51831CA201L	Cleaned
91	0.183	0.200	0.196	0.195	0.199	0.186	HD - MS51831CA201L	Cleaned
97	0.179	0.193	0.208	0.192	0.197	0.207	HD - MS51831CA201L	Cleaned
103	0.178	0.183	0.175	0.205	0.218	0.223	HD - MS51831CA201L	Cleaned

STATISTICAL RESULTS FOR INDIVIDUAL CYCLES

3.339	3.410	3.277	3.643	3.681	3.570	SUM
0.185	0.189	0.182	0.202	0.205	0.198	MEAN
0.184	0.190	0.177	0.203	0.203	0.192	MEDIAN
0.011	0.019	0.023	0.018	0.016	0.024	STDVA

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL
(With 95% Confidence for 90% of population)
(N = 18 : 90% = 1.974)

0.207665	0.227715	0.226684	0.23766	0.237034	0.245231	Kmax-90%
0.163302	0.151194	0.137431	0.167123	0.172018	0.151457	Kmin-90%

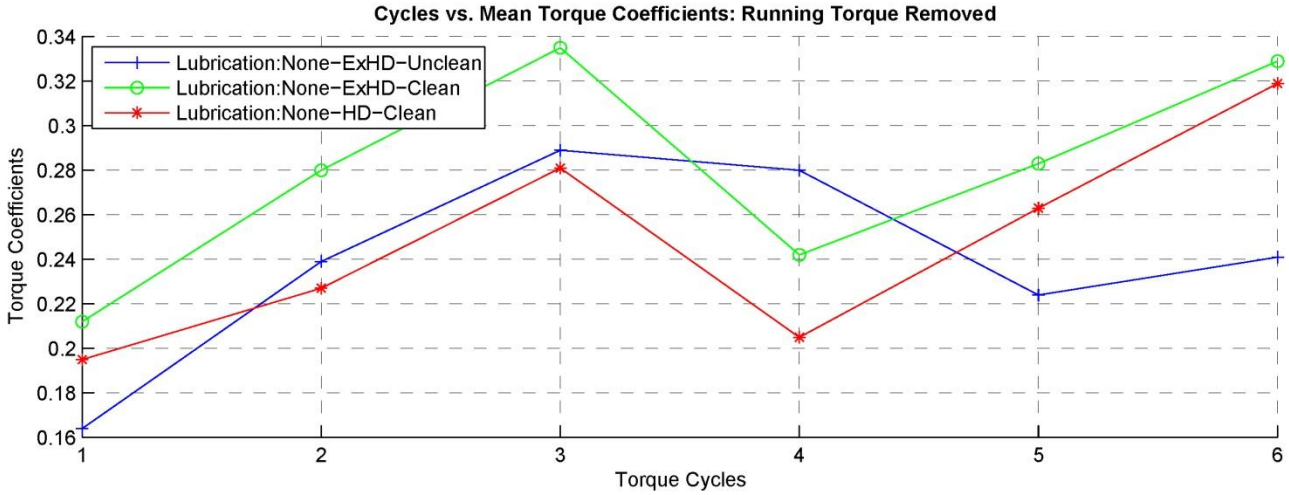
STATISTICAL RESULTS FOR COMBINED CYCLES

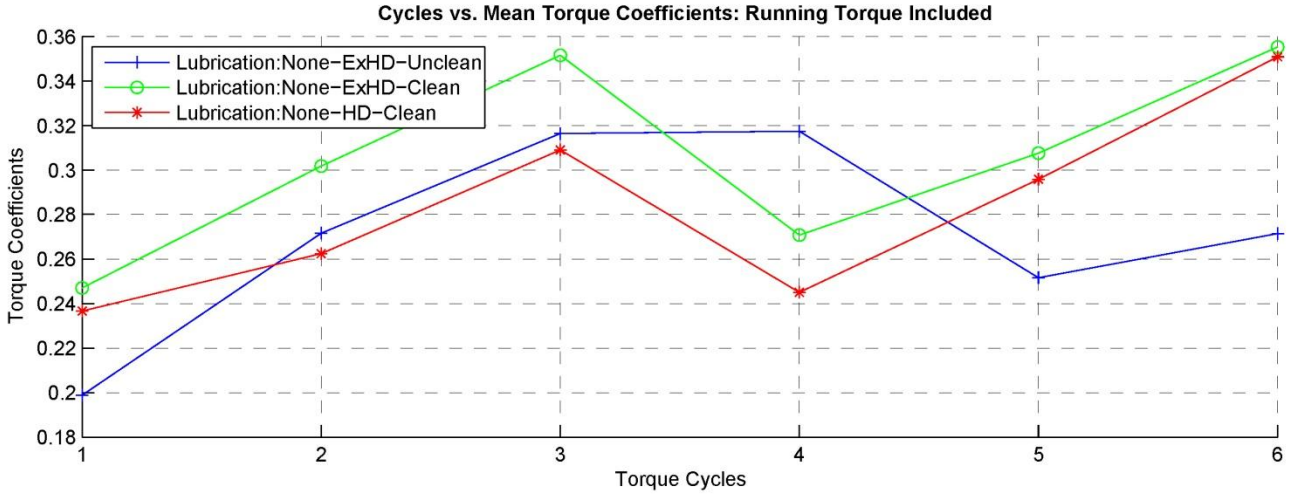
Sum	20.921
Mean	0.194
Median	0.192
Standard Deviation	0.020

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL
(With 95% Confidence for 90% of population)
(N = 108 : 90% = 1.646)

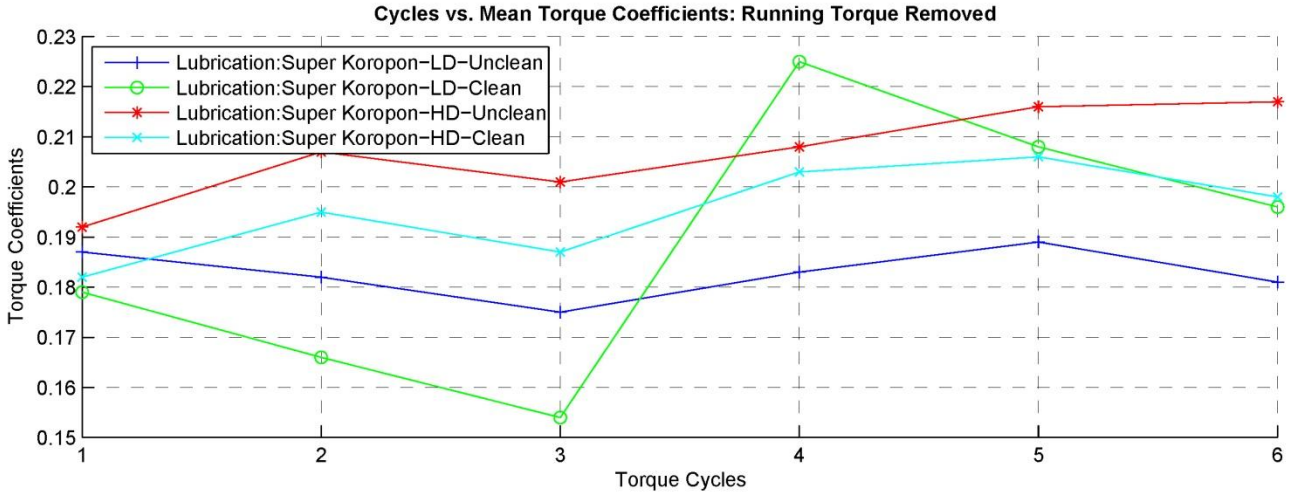
Kmax-90%	0.227347
Kmin-90%	0.160072

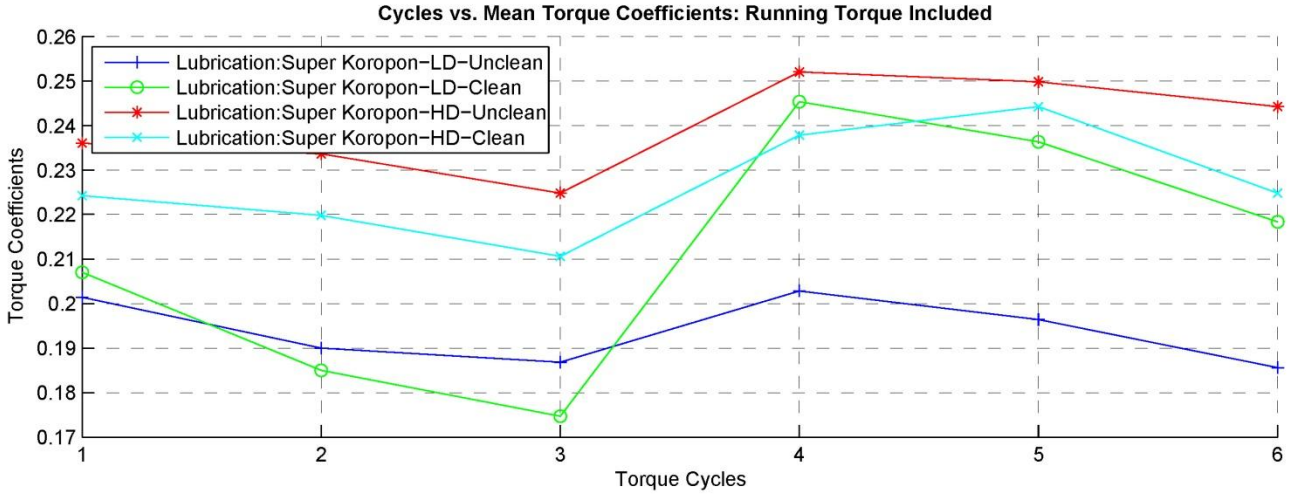
Cycles vs. Mean Torque Coefficients for Various #10−32 Locking Keenserts





Cycles vs. Mean Torque Coefficients for Various #10−32 Locking Keenserts

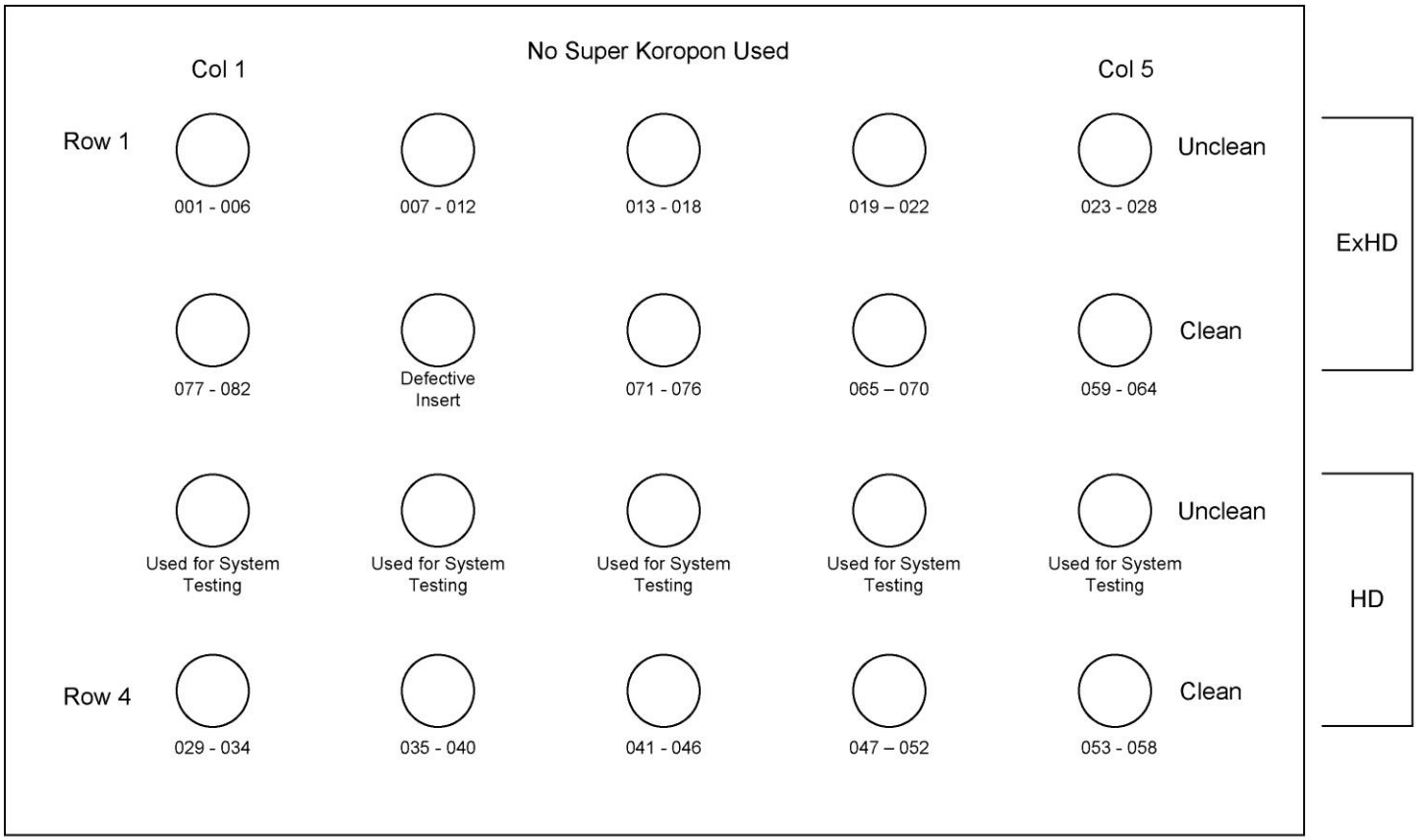




Appendix A:

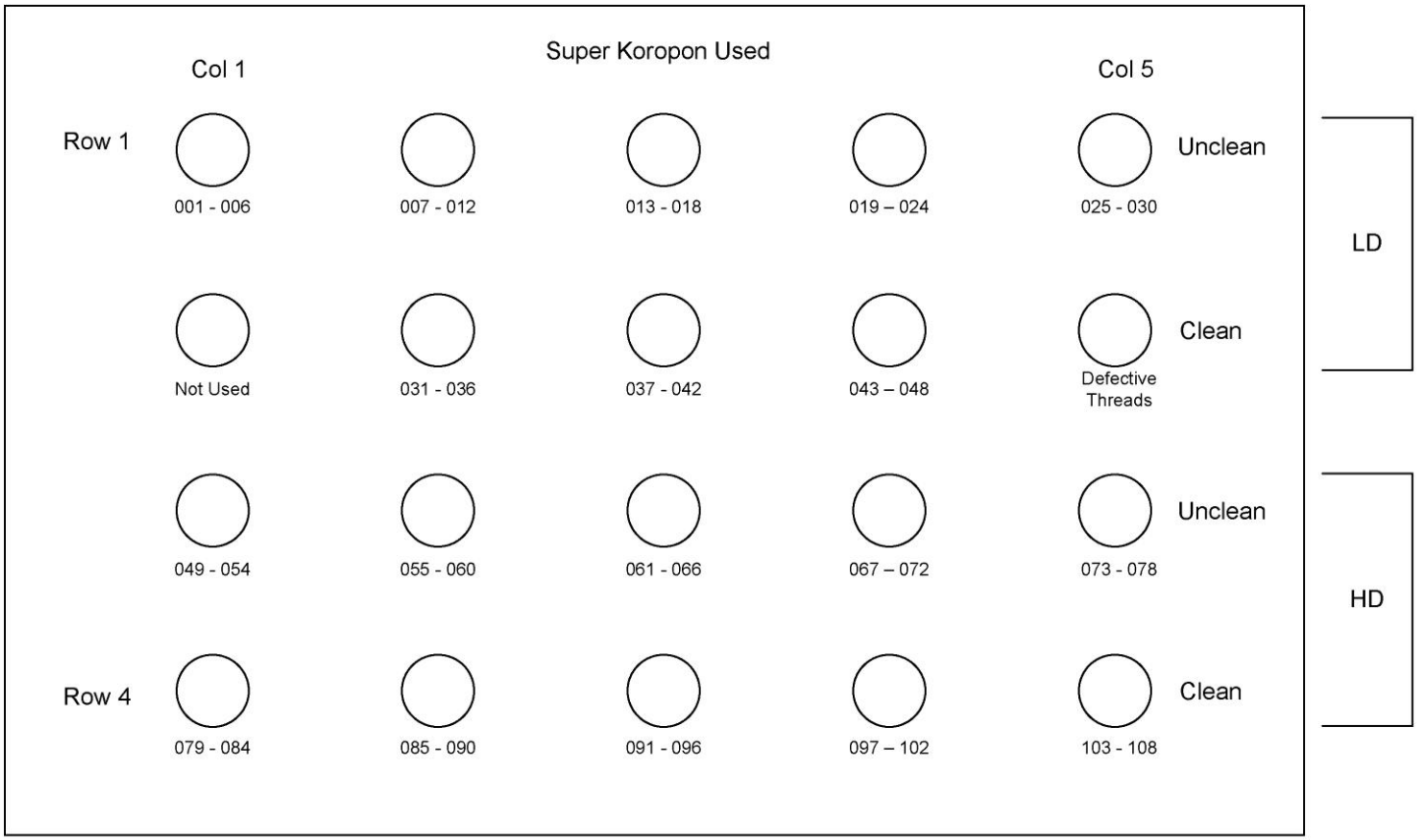
Section 1	10-32 Dry Torque Tension Plots
Section 2	10-32 Wet Torque Tension Plots
Section 3	10-32 Dry Running Torque Plots
Section 4	10-32 Wet Running Torque Plots
Section 5	10-32 Dry Cycle Plots: Torque vs. Load
Section 6	10-32 Wet Cycle Plots: Torque vs. Load
Section 7	10-32 Friction Coefficients
Section 8	10-32 Test Plate Layouts
Section 9	10-32 Dry Run Logs
Section 10	10-32 Wet Run Logs

#10-32 Fastener Plate No. 1 Layout (Not to scale)



HD = Heavy Duty inserts : MS51831CA201L : Lot No. 200174841-2
ExHD = Extra Heavy Duty inserts : MS51832CA201L

#10-32 Fastener Plate No. 2 Layout (Not to scale)



HD = Heavy Duty inserts : MS51831CA201L : Lot No. 200174841-2
LD = Light Duty inserts : MS51830CA201L : Lot No. BA711

Appendix A:

Section 1	10-32 Dry Torque Tension Plots
Section 2	10-32 Wet Torque Tension Plots
Section 3	10-32 Dry Running Torque Plots
Section 4	10-32 Wet Running Torque Plots
Section 5	10-32 Dry Cycle Plots: Torque vs. Load
Section 6	10-32 Wet Cycle Plots: Torque vs. Load
Section 7	10-32 Friction Coefficients
Section 8	10-32 Test Plate Layouts
Section 9	10-32 Dry Run Logs
Section 10	10-32 Wet Run Logs

NESC Orion Torque/Tension Run Log

Date: 7/21/2009
Time: 2:00 PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.2, 20.1, 50.1
Temperature(ºF): 72.1
Humidity(%): 56.0

Tor Wrench Op: C. McLeod

Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4 Clean
Washer: LMC21D5AC3C

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA201L Dry	HD MS51831CA201L Wet	ExHD MS51832CA201L Dry	ExHD MS51832CA201L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
1	1,1	1	NAS6703U12	#10-32 x .75	1765	105			X		9474	100 in-lb	
2	1,1	2	NAS6703U12	#10-32 x .75	1765	81			X		9474	100 in-lb	
3	1,1	3	NAS6703U12	#10-32 x .75	1765	94			X		9474	100 in-lb	
				Change Bolt									
4	1,1	1	NAS6703U12	#10-32 x .75	1765	91			X		9474	100 in-lb	
5	1,1	2	NAS6703U12	#10-32 x .75	1765	104			X		9474	100 in-lb	
6	1,1	3	NAS6703U12	#10-32 x .75	1765	111			X		9474	100 in-lb	
				Change Bolt									
7	1,2	1	NAS6703U12	#10-32 x .75	1765	60			X		9474	100 in-lb	
8	1,2	2	NAS6703U12	#10-32 x .75	1765	64			X		9474	100 in-lb	
9	1,2	3	NAS6703U12	#10-32 x .75	1765	79			X		9474	100 in-lb	
				Change Bolt									
10	1,2	4	NAS6703U12	#10-32 x .75	1765	58			X		9474	100 in-lb	
11	1,2	5	NAS6703U12	#10-32 x .75	1765	65			X		9474	100 in-lb	
12	1,2	6	NAS6703U12	#10-32 x .75	1765	72			X		9474	100 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 7/22/2009
Time: 9:15 AM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.1, 19.9, 50.3
Temperature(ºF): 71.0
Humidity(%): 61.0

Tor Wrench Op: C. McLeod

Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4 Clean
Washer: LMC21D5AC3C

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA201L Dry	HD MS51831CA201L Wet	ExHD MS51832CA201L Dry	ExHD MS51832CA201L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
13	1,3	1	NAS6703U12	#10-32 x .75	1765	56			X		9474	100 in-lb	
14	1,3	2	NAS6703U12	#10-32 x .75	1765	60			X		9474	100 in-lb	
15	1,3	3	NAS6703U12	#10-32 x .75	1765	94			X		9474	100 in-lb	
				Change Bolt									
16	1,3	1	NAS6703U12	#10-32 x .75	1765	72			X		9474	100 in-lb	
17	1,3	2	NAS6703U12	#10-32 x .75	1765	74			X		9474	100 in-lb	
18	1,3	3	NAS6703U12	#10-32 x .75	1765	97			X		9474	100 in-lb	
				Change Bolt									
19	1,4	1	NAS6703U12	#10-32 x .75	1765	81			X		9474	100 in-lb	
20	1,4	2	NAS6703U12	#10-32 x .75	1765	88			X		9474	100 in-lb	
21	1,4	3	NAS6703U12	#10-32 x .75	1765	109			X		9474	100 in-lb	
				Change Bolt									
22	1,4	4	NAS6703U12	#10-32 x .75	1765	NA			X		9474	100 in-lb	Bolt broke just above
	1,4	5	NAS6703U12	#10-32 x .75	1765				X		9474	100 in-lb	threads
	1,4	6	NAS6703U12	#10-32 x .75	1765				X		9474	100 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 7/22/2009
Time: 10:50 AM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.1, 19.9, 50.3
Temperature(ºF): 72.3
Humidity(%): 58.0

Tor Wrench Op: C. McLeod

Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4 Clean
Washer: LMC21D5AC3C

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA201L Dry	HD MS51831CA201L Wet	ExHD MS51832CA201L Dry	ExHD MS51832CA201L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
23	1,5	1	NAS6703U12	#10-32 x .75	1765	60			X		9474	100 in-lb	
24	1,5	2	NAS6703U12	#10-32 x .75	1765	69			X		9474	100 in-lb	
25	1,5	3	NAS6703U12	#10-32 x .75	1765	78			X		9474	100 in-lb	
				Change Bolt									
26	1,5	1	NAS6703U12	#10-32 x .75	1765	70			X		9474	100 in-lb	
27	1,5	2	NAS6703U12	#10-32 x .75	1765	89			X		9474	100 in-lb	
28	1,5	3	NAS6703U12	#10-32 x .75	1765	130			X		9474	100 in-lb	
				Change Bolt									
		1	NAS6703U12	#10-32 x .75	1765				X		9474	100 in-lb	
		2	NAS6703U12	#10-32 x .75	1765				X		9474	100 in-lb	
		3	NAS6703U12	#10-32 x .75	1765				X		9474	100 in-lb	
				Change Bolt									
		4	NAS6703U12	#10-32 x .75	1765				X		9474	100 in-lb	
		5	NAS6703U12	#10-32 x .75	1765				X		9474	100 in-lb	
		6	NAS6703U12	#10-32 x .75	1765				X		9474	100 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 7/27/2009
Time: 10:00 AM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.1, 20.0, 50.3
Temperature(ºF): 71.0
Humidity(%): 61.0

Tor Wrench Op: C. McLeod

Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4 Clean
Washer: LMC21D5AC3C

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA201L Dry	HD MS51831CA201L Wet	ExHD MS51832CA201L Dry	ExHD MS51832CA201L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
29	4,1	1	NAS6703U12	#10-32 x .75	1765	50	X				9474	100 in-lb	
30	4,1	2	NAS6703U12	#10-32 x .75	1765	52	X				9474	100 in-lb	
31	4,1	3	NAS6703U12	#10-32 x .75	1765	53	X				9474	100 in-lb	
				Change Bolt									
32	4,1	1	NAS6703U12	#10-32 x .75	1765	63	X				9474	100 in-lb	
33	4,1	2	NAS6703U12	#10-32 x .75	1765	87	X				9474	100 in-lb	
34	4,1	3	NAS6703U12	#10-32 x .75	1765	109	X				9474	100 in-lb	
				Change Bolt									
35	4,2	1	NAS6703U12	#10-32 x .75	1765	58	X				9474	100 in-lb	
36	4,2	2	NAS6703U12	#10-32 x .75	1765	69	X				9474	100 in-lb	
37	4,2	3	NAS6703U12	#10-32 x .75	1765	80	X				9474	100 in-lb	
				Change Bolt									
38	4,2	4	NAS6703U12	#10-32 x .75	1765	64	X				9474	100 in-lb	
39	4,2	5	NAS6703U12	#10-32 x .75	1765	80	X				9474	100 in-lb	
40	4,2	6	NAS6703U12	#10-32 x .75	1765	99	X				9474	100 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 7/28/2009
Time: 9:25 AM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.1, 20.0, 50.3
Temperature(ºF): 71.0
Humidity(%): 61.0

Tor Wrench Op: C. McLeod

Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4 Clean
Washer: LMC21D5AC3C

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA201L Dry	HD MS51831CA201L Wet	ExHD MS51832CA201L Dry	ExHD MS51832CA201L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
41	4,3	1	NAS6703U12	#10-32 x .75	1765	70	X				9474	100 in-lb	
42	4,3	2	NAS6703U12	#10-32 x .75	1765	76	X				9474	100 in-lb	
43	4,3	3	NAS6703U12	#10-32 x .75	1765	102	X				9474	100 in-lb	
				Change Bolt									
44	4,3	1	NAS6703U12	#10-32 x .75	1765	63	X				9474	100 in-lb	
45	4,3	2	NAS6703U12	#10-32 x .75	1765	86	X				9474	100 in-lb	
46	4,3	3	NAS6703U12	#10-32 x .75	1765	104	X				9474	100 in-lb	
				Change Bolt									
47	4,4	1	NAS6703U12	#10-32 x .75	1765	74	X				9474	100 in-lb	
48	4,4	2	NAS6703U12	#10-32 x .75	1765	86	X				9474	100 in-lb	
49	4,4	3	NAS6703U12	#10-32 x .75	1765	108	X				9474	100 in-lb	
				Change Bolt									
50	4,4	1	NAS6703U12	#10-32 x .75	1765	63	X				9474	100 in-lb	Premature stop
51	4,4	2	NAS6703U12	#10-32 x .75	1765	77	X				9474	100 in-lb	
52	4,4	3	NAS6703U12	#10-32 x .75	1765	95	X				9474	100 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 7/28/2009
Time: 10:30 AM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.1, 20.0, 50.3
Temperature(ºF): 71.7
Humidity(%): 59.0

Tor Wrench Op: C. McLeod

Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4 Clean
Washer: LMC21D5AC3C

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA201L Dry	HD MS51831CA201L Wet	ExHD MS51832CA201L Dry	ExHD MS51832CA201L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
53	4,5	1	NAS6703U12	#10-32 x .75	1765	60	X				9474	100 in-lb	
54	4,5	2	NAS6703U12	#10-32 x .75	1765	73	X				9474	100 in-lb	
55	4,5	3	NAS6703U12	#10-32 x .75	1765	83	X				9474	100 in-lb	
				Change Bolt									
56	4,5	1	NAS6703U12	#10-32 x .75	1765	66	X				9474	100 in-lb	
57	4,5	2	NAS6703U12	#10-32 x .75	1765	85	X				9474	100 in-lb	
58	4,5	3	NAS6703U12	#10-32 x .75	1765	101	X				9474	100 in-lb	
				Change Bolt									
		1	NAS6703U12	#10-32 x .75	1765		X				9474	100 in-lb	
		2	NAS6703U12	#10-32 x .75	1765		X				9474	100 in-lb	
		3	NAS6703U12	#10-32 x .75	1765		X				9474	100 in-lb	
				Change Bolt									
		1	NAS6703U12	#10-32 x .75	1765		X				9474	100 in-lb	
		2	NAS6703U12	#10-32 x .75	1765		X				9474	100 in-lb	
		3	NAS6703U12	#10-32 x .75	1765		X				9474	100 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 7/28/2009
Time: 2:25 PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.1, 20.0, 50.3
Temperature(ºF): 71.9
Humidity(%): 58.0

Tor Wrench Op: C. McLeod

Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4 Clean
Washer: LMC21D5AC3C

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA201L Dry	HD MS51831CA201L Wet	ExHD MS51832CA201L Dry	ExHD MS51832CA201L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
59	2,5	1	NAS6703U12	#10-32 x .75	1765	61			X		9474	100 in-lb	
60	2,5	2	NAS6703U12	#10-32 x .75	1765	79			X		9474	100 in-lb	
61	2,5	3	NAS6703U12	#10-32 x .75	1765	108			X		9474	100 in-lb	
				Change Bolt									
62	2,5	1	NAS6703U12	#10-32 x .75	1765	68			X		9474	100 in-lb	
63	2,5	2	NAS6703U12	#10-32 x .75	1765	88			X		9474	100 in-lb	
64	2,5	3	NAS6703U12	#10-32 x .75	1765	106			X		9474	100 in-lb	
				Change Bolt									
65	2,4	1	NAS6703U12	#10-32 x .75	1765	65			X		9474	100 in-lb	
66	2,4	2	NAS6703U12	#10-32 x .75	1765	79			X		9474	100 in-lb	
67	2,4	3	NAS6703U12	#10-32 x .75	1765	95			X		9474	100 in-lb	
				Change Bolt									
68	2,4	1	NAS6703U12	#10-32 x .75	1765	68			X		9474	100 in-lb	
69	2,4	2	NAS6703U12	#10-32 x .75	1765	81			X		9474	100 in-lb	
70	2,4	3	NAS6703U12	#10-32 x .75	1765	96			X		9474	100 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 7/28/2009
Time: 3:07 PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.1, 20.0, 50.3
Temperature(ºF): 72.5
Humidity(%): 58.0

Tor Wrench Op: C. McLeod

Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4 Clean
Washer: LMC21D5AC3C

ExHD Insert 2,2 is defective

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA201L Dry	HD MS51831CA201L Wet	ExHD MS51832CA201L Dry	ExHD MS51832CA201L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
71	2,3	1	NAS6703U12	#10-32 x .75	1765	60			X		9474	100 in-lb	
72	2,3	2	NAS6703U12	#10-32 x .75	1765	89			X		9474	100 in-lb	
73	2,3	3	NAS6703U12	#10-32 x .75	1765	109			X		9474	100 in-lb	
				Change Bolt									
74	2,3	1	NAS6703U12	#10-32 x .75	1765	71			X		9474	100 in-lb	
75	2,3	2	NAS6703U12	#10-32 x .75	1765	85			X		9474	100 in-lb	
76	2,3	3	NAS6703U12	#10-32 x .75	1765	110			X		9474	100 in-lb	
				Change Bolt									
77	2,1	1	NAS6703U12	#10-32 x .75	1765	71			X		9474	100 in-lb	
78	2,1	2	NAS6703U12	#10-32 x .75	1765	90			X		9474	100 in-lb	
79	2,1	3	NAS6703U12	#10-32 x .75	1765	107			X		9474	100 in-lb	
				Change Bolt									
80	2,1	1	NAS6703U12	#10-32 x .75	1765	92			X		9474	100 in-lb	
81	2,1	2	NAS6703U12	#10-32 x .75	1765	115			X		9474	100 in-lb	
82	2,1	3	NAS6703U12	#10-32 x .75	1765	130			X		9474	100 in-lb	
				Change Bolt									

Appendix A:

Section 1	10-32 Dry Torque Tension Plots
Section 2	10-32 Wet Torque Tension Plots
Section 3	10-32 Dry Running Torque Plots
Section 4	10-32 Wet Running Torque Plots
Section 5	10-32 Dry Cycle Plots: Torque vs. Load
Section 6	10-32 Wet Cycle Plots: Torque vs. Load
Section 7	10-32 Friction Coefficients
Section 8	10-32 Test Plate Layouts
Section 9	10-32 Dry Run Logs
Section 10	10-32 Wet Run Logs

NESC Orion Torque/Tension Run Log

Date: 12/2/2009
Time: 2:00 PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.1, 19.9, 49.8
Temperature(ºF): 71.2
Humidity(%): 47.0

Tor Wrench Op: Walt P.
Data Sys. Op: Wayne Goodman
Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4Clean
Washer: LMC21D5AC3C
The torque wrench used is a 600 in-lb torque wrench calibrated out to 300 in-lb
Super Koropon used

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA201L Dry	HD MS51831CA201L Wet	LD MS51830CA201L Dry	LD MS51830CA201L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
1	1,1	1	NAS6703U12	#10-32 x .75	1765	58				X	9644	300 in-lb	
2	1,1	2	NAS6703U12	#10-32 x .75	1765	60				X	9644	300 in-lb	
3	1,1	3	NAS6703U12	#10-32 x .75	1765	51				X	9644	300 in-lb	Operator Error: Tor. W
				Change Bolt									
4	1,1	1	NAS6703U12	#10-32 x .75	1765	55				X	9644	300 in-lb	
5	1,1	2	NAS6703U12	#10-32 x .75	1765	59				X	9644	300 in-lb	
6	1,1	3	NAS6703U12	#10-32 x .75	1765	46				X	9644	300 in-lb	
				Change Bolt									
7	1,2	1	NAS6703U12	#10-32 x .75	1765	61				X	9644	300 in-lb	
8	1,2	2	NAS6703U12	#10-32 x .75	1765	48				X	9644	300 in-lb	
9	1,2	3	NAS6703U12	#10-32 x .75	1765	43				X	9644	300 in-lb	
				Change Bolt									
10	1,2	4	NAS6703U12	#10-32 x .75	1765	69				X	9644	300 in-lb	Operator Error: Tor. W
11	1,2	5	NAS6703U12	#10-32 x .75	1765	57				X	9644	300 in-lb	
12	1,2	6	NAS6703U12	#10-32 x .75	1765	52				X	9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 12/2/2009
Time: 3:00 PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.0, 19.9, 20.0
Temperature(ºF): 71.4
Humidity(%): 48.0

Tor Wrench Op: Walt P.
Data Sys. Op: Wayne Goodman
Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4Clean
Washer: LMC21D5AC3C
The torque wrench used is a 600 in-lb torque wrench
calibrated out to 300 in-lb
Super Koropon used

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA201L Dry	HD MS51831CA201L Wet	LD MS51830CA201L Dry	LD MS51830CA201L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
13	1,3	1	NAS6703U12	#10-32 x .75	1765	54				X	9644	300 in-lb	
14	1,3	2	NAS6703U12	#10-32 x .75	1765	66				X	9644	300 in-lb	
15	1,3	3	NAS6703U12	#10-32 x .75	1765	70				X	9644	300 in-lb	44 Data Points
				Change Bolt									
16	1,3	1	NAS6703U12	#10-32 x .75	1765	65				X	9644	300 in-lb	
17	1,3	2	NAS6703U12	#10-32 x .75	1765	52				X	9644	300 in-lb	
18	1,3	3	NAS6703U12	#10-32 x .75	1765	51				X	9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 12/4/2009
Time: 9:40 AM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.1, 20.0, 50.0
Temperature(ºF): 70.3
Humidity(%): 42.0

Tor Wrench Op: Chris McLeod
Data Sys. Op: Wayne Goodman
Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4Clean
Washer: LMC21D5AC3C
The torque wrench used is a 600 in-lb torque wrench calibrated out to 300 in-lb
Super Koropon used

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA201L Dry	HD MS51831CA201L Wet	LD MS51830CA201L Dry	LD MS51830CA201L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
19	1,4	1	NAS6703U12	#10-32 x .75	1765	54				X	9644	300 in-lb	
20	1,4	2	NAS6703U12	#10-32 x .75	1765	49				X	9644	300 in-lb	
21	1,4	3	NAS6703U12	#10-32 x .75	1765	46				X	9644	300 in-lb	
				Change Bolt									
22	1,4	1	NAS6703U12	#10-32 x .75	1765	53				X	9644	300 in-lb	
23	1,4	2	NAS6703U12	#10-32 x .75	1765	49				X	9644	300 in-lb	
24	1,4	3	NAS6703U12	#10-32 x .75	1765	46				X	9644	300 in-lb	
				Change Bolt									
25	1,5	1	NAS6703U12	#10-32 x .75	1765	56				X	9644	300 in-lb	
26	1,5	2	NAS6703U12	#10-32 x .75	1765	47				X	9644	300 in-lb	
27	1,5	3	NAS6703U12	#10-32 x .75	1765	46				X	9644	300 in-lb	
				Change Bolt									
28	1,5	4	NAS6703U12	#10-32 x .75	1765	57				X	9644	300 in-lb	
29	1,5	5	NAS6703U12	#10-32 x .75	1765	54				X	9644	300 in-lb	
30	1,5	6	NAS6703U12	#10-32 x .75	1765	48				X	9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 12/7/2009
Time: 8:30 AM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.0, 19.9, 49.8
Temperature(ºF): 67.2
Humidity(%): 41.0

Tor Wrench Op: Kevin Hagerich
Data Sys. Op: Wayne Goodman
Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4Clean
Washer: LMC21D5AC3C
The torque wrench used is a 600 in-lb torque wrench
calibrated out to 300 in-lb
Super Koropon used

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA201L Dry	HD MS51831CA201L Wet	LD MS51830CA201L Dry	LD MS51830CA201L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
31	2,2	1	NAS6703U12	#10-32 x .75	1765	56				X	9644	300 in-lb	
32	2,2	2	NAS6703U12	#10-32 x .75	1765	48				X	9644	300 in-lb	
33	2,2	3	NAS6703U12	#10-32 x .75	1765	46				X	9644	300 in-lb	
				Change Bolt									
34	2,2	1	NAS6703U12	#10-32 x .75	1765	74				X	9644	300 in-lb	
35	2,2	2	NAS6703U12	#10-32 x .75	1765	64				X	9644	300 in-lb	
36	2,2	3	NAS6703U12	#10-32 x .75	1765	66				X	9644	300 in-lb	
				Change Bolt									
37	2,3	1	NAS6703U12	#10-32 x .75	1765	61				X	9644	300 in-lb	
38	2,3	2	NAS6703U12	#10-32 x .75	1765	49				X	9644	300 in-lb	
39	2,3	3	NAS6703U12	#10-32 x .75	1765	48				X	9644	300 in-lb	
				Change Bolt									
40	2,3	4	NAS6703U12	#10-32 x .75	1765	58				X	9644	300 in-lb	
41	2,3	5	NAS6703U12	#10-32 x .75	1765	44				X	9644	300 in-lb	
42	2,3	6	NAS6703U12	#10-32 x .75	1765	51				X	9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 12/7/2009
Time: 1:18 PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.0, 19.9, 49.8
Temperature(ºF): 68.3
Humidity(%): 39.0

Tor Wrench Op: Kevin Hagerich
Data Sys. Op: Wayne Goodman
Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4Clean
Washer: LMC21D5AC3C
The torque wrench used is a 600 in-lb torque wrench
calibrated out to 300 in-lb
Super Koropon used

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA201L		Keensert Type LD MS51830CA201L		Torq. Wrench		Comments
							Dry	Wet	Dry	Wet	S/N	Capacity	
43	2,4	1	NAS6703U12	#10-32 x .75	1765	64				X	9644	300 in-lb	Changed Clamp
44	2,4	2	NAS6703U12	#10-32 x .75	1765	58				X	9644	300 in-lb	threshhold to 30lb
45	2,4	3	NAS6703U12	#10-32 x .75	1765	47				X	9644	300 in-lb	
				Change Bolt									
46	2,4	1	NAS6703U12	#10-32 x .75	1765	76				X	9644	300 in-lb	
47	2,4	2	NAS6703U12	#10-32 x .75	1765	78				X	9644	300 in-lb	
48	2,4	3	NAS6703U12	#10-32 x .75	1765	64				X	9644	300 in-lb	
				Change Bolt									
	2,5	1	NAS6703U12	#10-32 x .75	1765					X	9644	300 in-lb	Defective threads
	2,5	2	NAS6703U12	#10-32 x .75	1765					X	9644	300 in-lb	
	2,5	3	NAS6703U12	#10-32 x .75	1765					X	9644	300 in-lb	
				Change Bolt									
	2,5	4	NAS6703U12	#10-32 x .75	1765					X	9644	300 in-lb	
	2,5	5	NAS6703U12	#10-32 x .75	1765					X	9644	300 in-lb	
	2,5	6	NAS6703U12	#10-32 x .75	1765					X	9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 12/7/2009
Time: 1:50 PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.0, 19.9, 49.8
Temperature(ºF): 68.7
Humidity(%): 39.0

Tor Wrench Op: Kevin Hagerich
Data Sys. Op: Wayne Goodman
Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4Clean
Washer: LMC21D5AC3C
The torque wrench used is a 600 in-lb torque wrench
calibrated out to 300 in-lb
Super Koropon used

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA201L Dry	Keensert Type HD MS51831CA201L Wet	Keensert Type LD MS51830CA201L Dry	Keensert Type LD MS51830CA201L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
49	3,1	1	NAS6703U12	#10-32 x .75	1765	64		X			9644	300 in-lb	
50	3,1	2	NAS6703U12	#10-32 x .75	1765	66		X			9644	300 in-lb	
51	3,1	3	NAS6703U12	#10-32 x .75	1765	54		X			9644	300 in-lb	
				Change Bolt									
52	3,1	1	NAS6703U12	#10-32 x .75	1765	66		X			9644	300 in-lb	
53	3,1	2	NAS6703U12	#10-32 x .75	1765	69		X			9644	300 in-lb	
54	3,1	3	NAS6703U12	#10-32 x .75	1765	65		X			9644	300 in-lb	
				Change Bolt									
55	3,2	1	NAS6703U12	#10-32 x .75	1765	67		X			9644	300 in-lb	
56	3,2	2	NAS6703U12	#10-32 x .75	1765	76		X			9644	300 in-lb	
57	3,2	3	NAS6703U12	#10-32 x .75	1765	65		X			9644	300 in-lb	
				Change Bolt									
58	3,2	4	NAS6703U12	#10-32 x .75	1765	81		X			9644	300 in-lb	
59	3,2	5	NAS6703U12	#10-32 x .75	1765	77		X			9644	300 in-lb	
60	3,2	6	NAS6703U12	#10-32 x .75	1765	70		X			9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 12/7/2009
Time: 2:30 PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.0, 19.9, 49.8
Temperature(ºF): 68.7
Humidity(%): 39.0

Tor Wrench Op: Kevin Hagerich
Data Sys. Op: Wayne Goodman
Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4Clean
Washer: LMC21D5AC3C
The torque wrench used is a 600 in-lb torque wrench
calibrated out to 300 in-lb
Super Koropon used

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA201L Dry	Keensert Type HD MS51831CA201L Wet	Keensert Type LD MS51830CA201L Dry	Keensert Type LD MS51830CA201L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
61	3,3	1	NAS6703U12	#10-32 x .75	1765	66		X			9644	300 in-lb	
62	3,3	2	NAS6703U12	#10-32 x .75	1765	59		X			9644	300 in-lb	
63	3,3	3	NAS6703U12	#10-32 x .75	1765	59		X			9644	300 in-lb	
				Change Bolt									
64	3,3	1	NAS6703U12	#10-32 x .75	1765	68		X			9644	300 in-lb	
65	3,3	2	NAS6703U12	#10-32 x .75	1765	76		X			9644	300 in-lb	
66	3,3	3	NAS6703U12	#10-32 x .75	1765	76		X			9644	300 in-lb	
				Change Bolt									
67	3,4	1	NAS6703U12	#10-32 x .75	1765	72		X			9644	300 in-lb	
68	3,4	2	NAS6703U12	#10-32 x .75	1765	78		X			9644	300 in-lb	
69	3,4	3	NAS6703U12	#10-32 x .75	1765	68		X			9644	300 in-lb	
				Change Bolt									
70	3,4	4	NAS6703U12	#10-32 x .75	1765	80		X			9644	300 in-lb	
71	3,4	5	NAS6703U12	#10-32 x .75	1765	75		X			9644	300 in-lb	
72	3,4	6	NAS6703U12	#10-32 x .75	1765	67		X			9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 12/7/2009
Time: 2:55 PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.0, 19.9, 49.8
Temperature(ºF): 68.5
Humidity(%): 39.0

Tor Wrench Op: Kevin Hagerich
Data Sys. Op: Wayne Goodman
Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4Clean
Washer: LMC21D5AC3C
The torque wrench used is a 600 in-lb torque wrench
calibrated out to 300 in-lb
Super Koropon used

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA201L Dry	Keensert Type HD MS51831CA201L Wet	Keensert Type LD MS51830CA201L Dry	Keensert Type LD MS51830CA201L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
73	3,5	1	NAS6703U12	#10-32 x .75	1765	67		X			9644	300 in-lb	
74	3,5	2	NAS6703U12	#10-32 x .75	1765	69		X			9644	300 in-lb	
75	3,5	3	NAS6703U12	#10-32 x .75	1765	67		X			9644	300 in-lb	
				Change Bolt									
76	3,5	1	NAS6703U12	#10-32 x .75	1765	67		X			9644	300 in-lb	
77	3,5	2	NAS6703U12	#10-32 x .75	1765	69		X			9644	300 in-lb	
78	3,5	3	NAS6703U12	#10-32 x .75	1765	63		X			9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 12/8/2009
Time: 7:25 AM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.0, 19.8, 49.8
Temperature(ºF): 68.3
Humidity(%): 41.0

Tor Wrench Op: Kevin Hagerich
Data Sys. Op: Wayne Goodman
Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4Clean
Washer: LMC21D5AC3C
The torque wrench used is a 600 in-lb torque wrench
calibrated out to 300 in-lb
Super Koropon used

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA201L Dry	Keensert Type HD MS51831CA201L Wet	Keensert Type LD MS51830CA201L Dry	Keensert Type LD MS51830CA201L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
79	4,1	1	NAS6703U12	#10-32 x .75	1765	57		X			9644	300 in-lb	
80	4,1	2	NAS6703U12	#10-32 x .75	1765	61		X			9644	300 in-lb	
81	4,1	3	NAS6703U12	#10-32 x .75	1765	58		X			9644	300 in-lb	
				Change Bolt									
82	4,1	1	NAS6703U12	#10-32 x .75	1765	69		X			9644	300 in-lb	
83	4,1	2	NAS6703U12	#10-32 x .75	1765	76		X			9644	300 in-lb	
84	4,1	3	NAS6703U12	#10-32 x .75	1765	64		X			9644	300 in-lb	
				Change Bolt									
85	4,2	1	NAS6703U12	#10-32 x .75	1765	62		X			9644	300 in-lb	
86	4,2	2	NAS6703U12	#10-32 x .75	1765	64		X			9644	300 in-lb	
87	4,2	3	NAS6703U12	#10-32 x .75	1765	51		X			9644	300 in-lb	
				Change Bolt									
88	4,2	4	NAS6703U12	#10-32 x .75	1765	67		X			9644	300 in-lb	
89	4,2	5	NAS6703U12	#10-32 x .75	1765	64		X			9644	300 in-lb	
90	4,2	6	NAS6703U12	#10-32 x .75	1765	54		X			9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 12/8/2009
Time: 8:00 AM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.0, 19.8, 49.8
Temperature(ºF): 68.7
Humidity(%): 41.0

Tor Wrench Op: Kevin Hagerich
Data Sys. Op: Wayne Goodman
Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4Clean
Washer: LMC21D5AC3C
The torque wrench used is a 600 in-lb torque wrench calibrated out to 300 in-lb
Super Koropon used

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA201L Dry	Keensert Type HD MS51831CA201L Wet	Keensert Type LD MS51830CA201L Dry	Keensert Type LD MS51830CA201L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
91	4,3	1	NAS6703U12	#10-32 x .75	1765	59		X			9644	300 in-lb	
92	4,3	2	NAS6703U12	#10-32 x .75	1765	65		X			9644	300 in-lb	
93	4,3	3	NAS6703U12	#10-32 x .75	1765	58		X			9644	300 in-lb	
				Change Bolt									
94	4,3	1	NAS6703U12	#10-32 x .75	1765	72		X			9644	300 in-lb	
95	4,3	2	NAS6703U12	#10-32 x .75	1765	72		X			9644	300 in-lb	
96	4,3	3	NAS6703U12	#10-32 x .75	1765	65		X			9644	300 in-lb	
				Change Bolt									
97	4,4	1	NAS6703U12	#10-32 x .75	1765	58		X			9644	300 in-lb	
98	4,4	2	NAS6703U12	#10-32 x .75	1765	61		X			9644	300 in-lb	
99	4,4	3	NAS6703U12	#10-32 x .75	1765	66		X			9644	300 in-lb	
				Change Bolt									
100	4,4	4	NAS6703U12	#10-32 x .75	1765	56		X			9644	300 in-lb	
101	4,4	5	NAS6703U12	#10-32 x .75	1765	70		X			9644	300 in-lb	
102	4,4	6	NAS6703U12	#10-32 x .75	1765	63		X			9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 12/8/2009
Time: 11:10 AM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.0, 19.8, 49.8
Temperature(ºF): 69.4
Humidity(%): 40.0

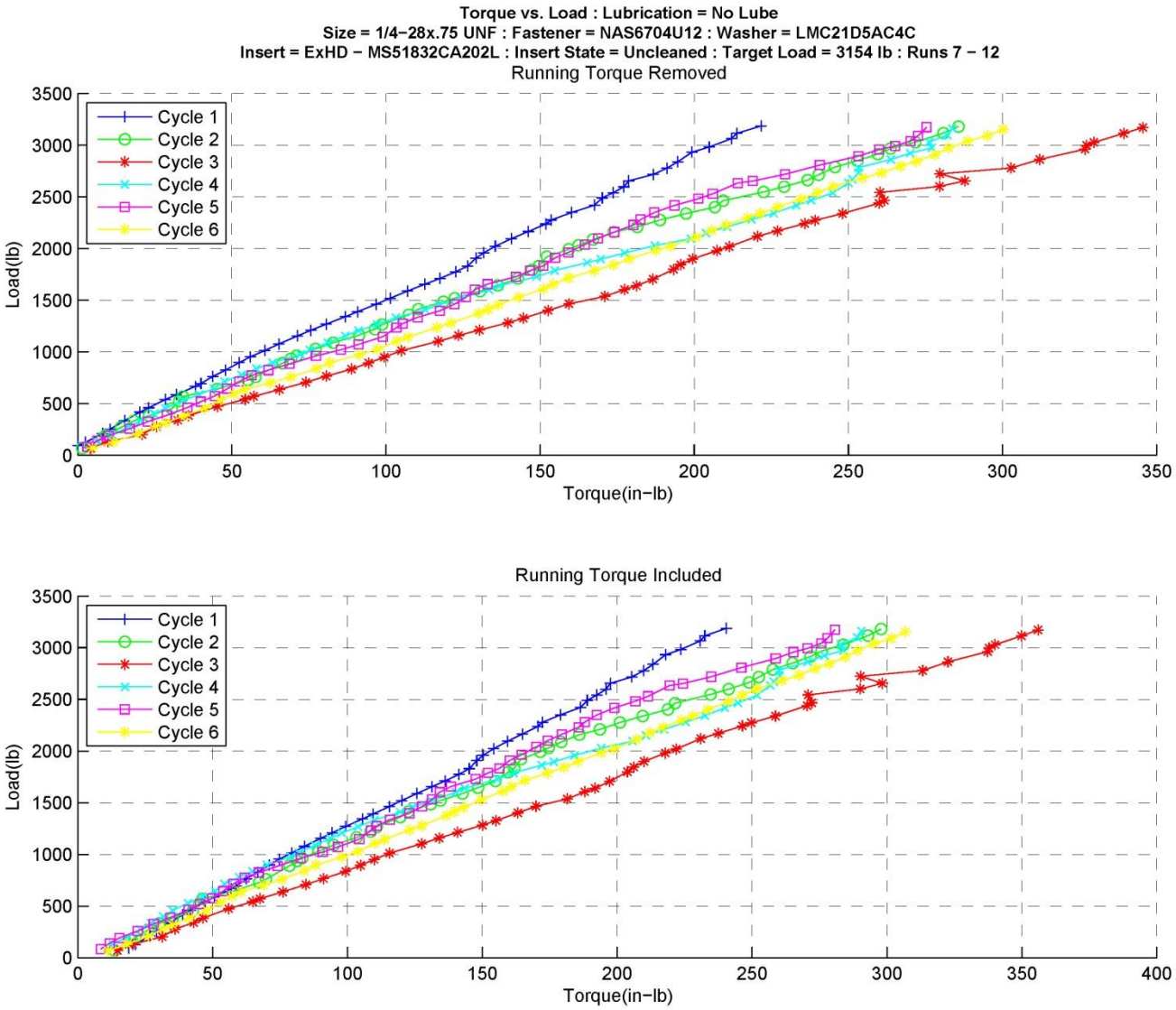
Tor Wrench Op: Kevin Hagerich
Data Sys. Op: Wayne Goodman
Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4Clean
Washer: LMC21D5AC3C
The torque wrench used is a 600 in-lb torque wrench
calibrated out to 300 in-lb
Super Koropon used

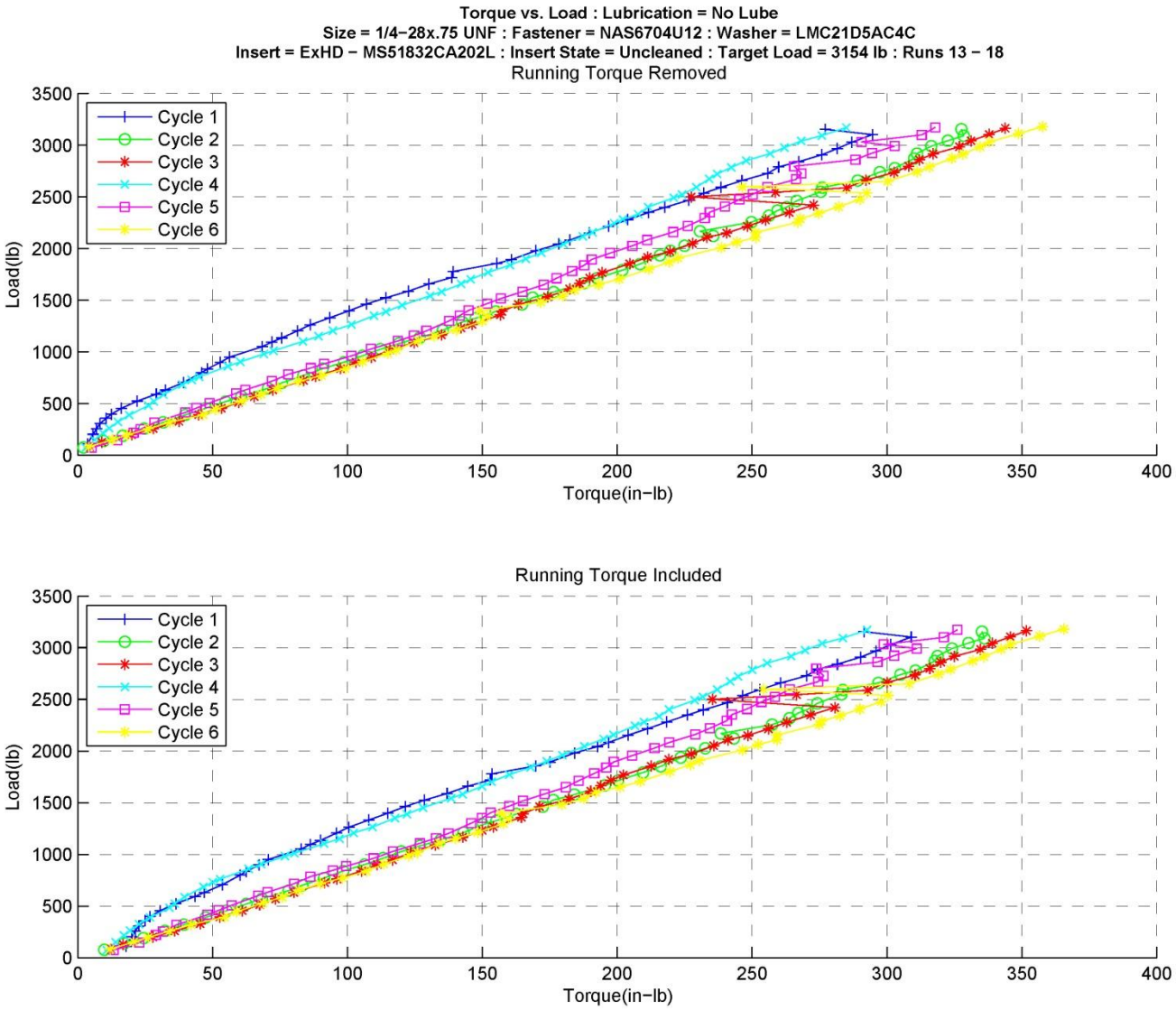
Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA201L		Keensert Type LD MS51830CA201L		Torq. Wrench		Comments
							Dry	Wet	Dry	Wet	S/N	Capacity	
103	4,5	1	NAS6703U12	#10-32 x .75	1765	54		X			9644	300 in-lb	
104	4,5	2	NAS6703U12	#10-32 x .75	1765	62		X			9644	300 in-lb	
105	4,5	3	NAS6703U12	#10-32 x .75	1765	60		X			9644	300 in-lb	
				Change Bolt									
106	4,5	1	NAS6703U12	#10-32 x .75	1765	61		X			9644	300 in-lb	
107	4,5	2	NAS6703U12	#10-32 x .75	1765	62		X			9644	300 in-lb	
108	4,5	3	NAS6703U12	#10-32 x .75	1765	71		X			9644	300 in-lb	
				Change Bolt									

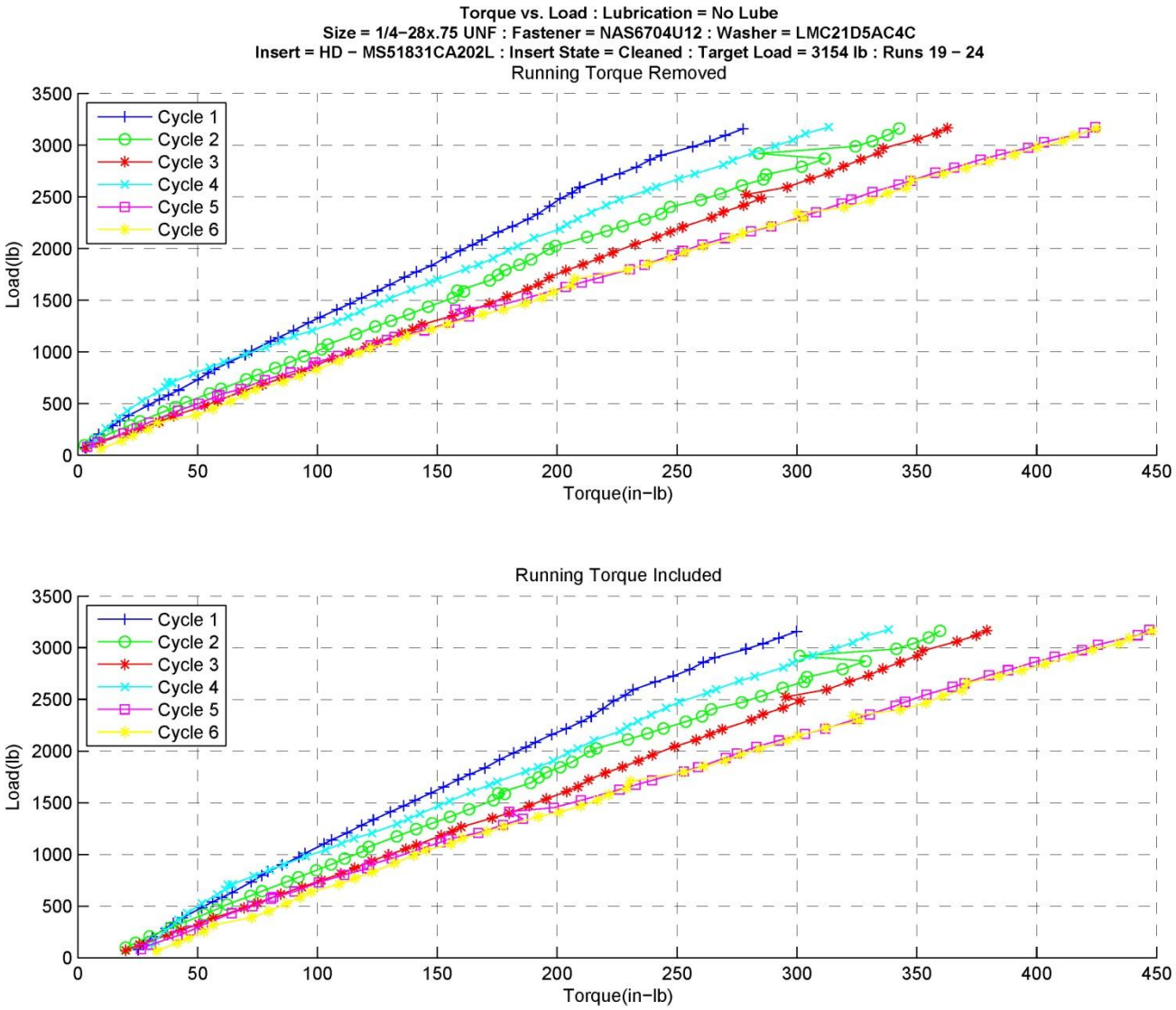
Appendix B – Full set of 1/4-28 Torque Tension and Running Torque Plots, Excel® Torque Coefficient Data at 65 percent Pre Load, Test Plate Layouts and complete set of Run Logs.

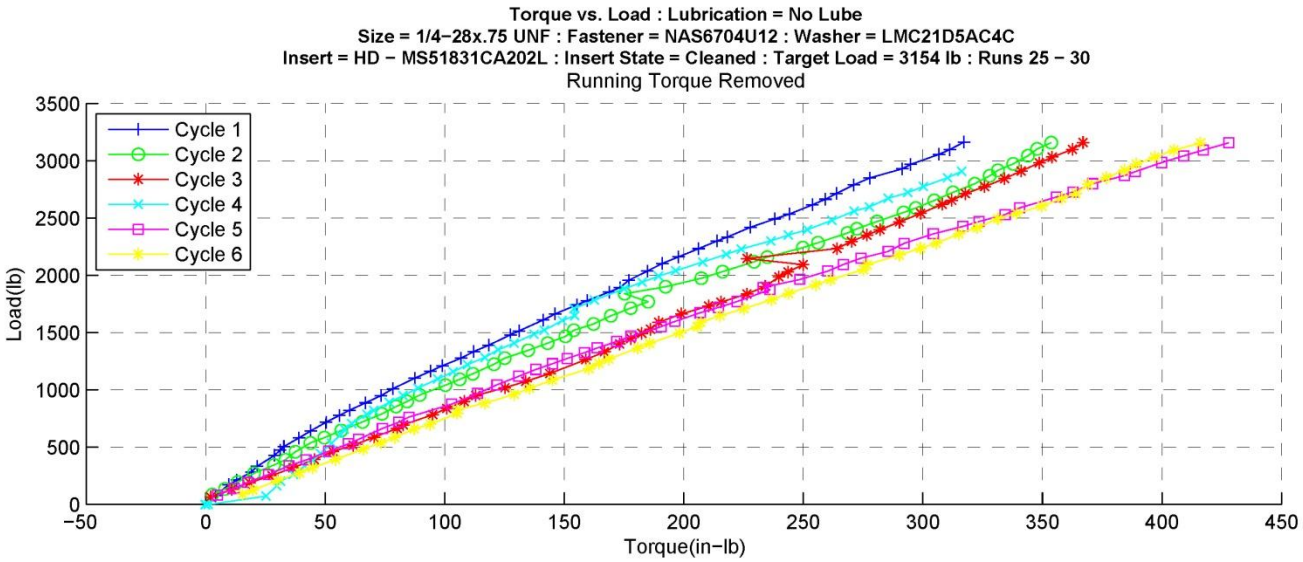
Appendix B:

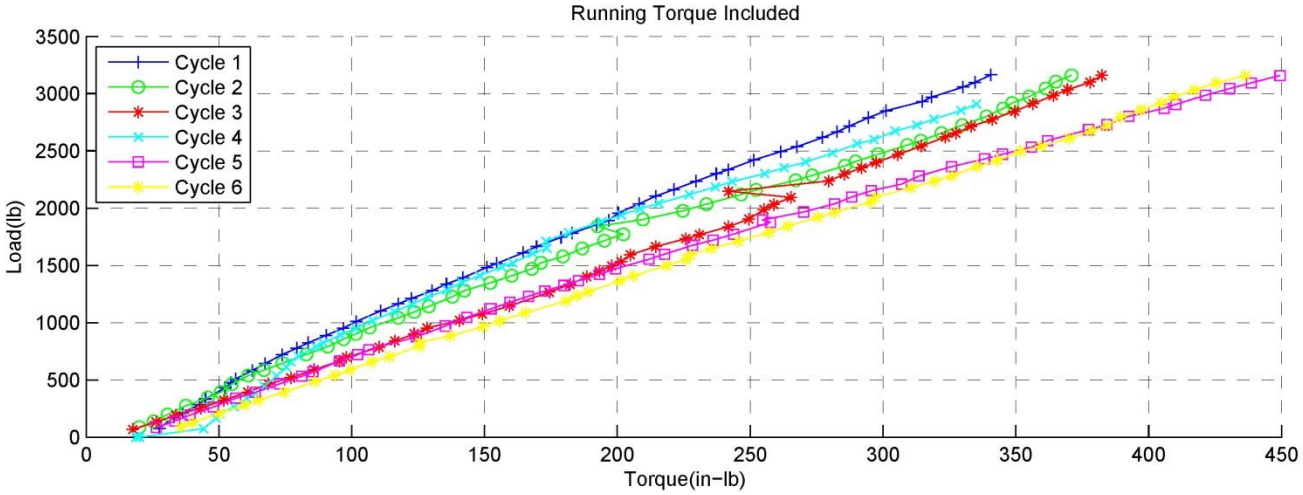
Section 1	¼-28 Dry Torque Tension Plots
Section 2	¼-28 Wet Torque Tension Plots
Section 3	¼-28 Dry Running Torque Plots
Section 4	¼-28 Wet Running Torque Plots
Section 5	¼-28 Dry Cycle Plots: Torque vs. Load
Section 6	¼-28 Wet Cycle Plots: Torque vs. Load
Section 7	¼-28 Friction Coefficients
Section 8	¼-28 Test Plate Layouts
Section 9	¼-28 Dry Run Logs
Section 10	¼-28 Wet Run Logs

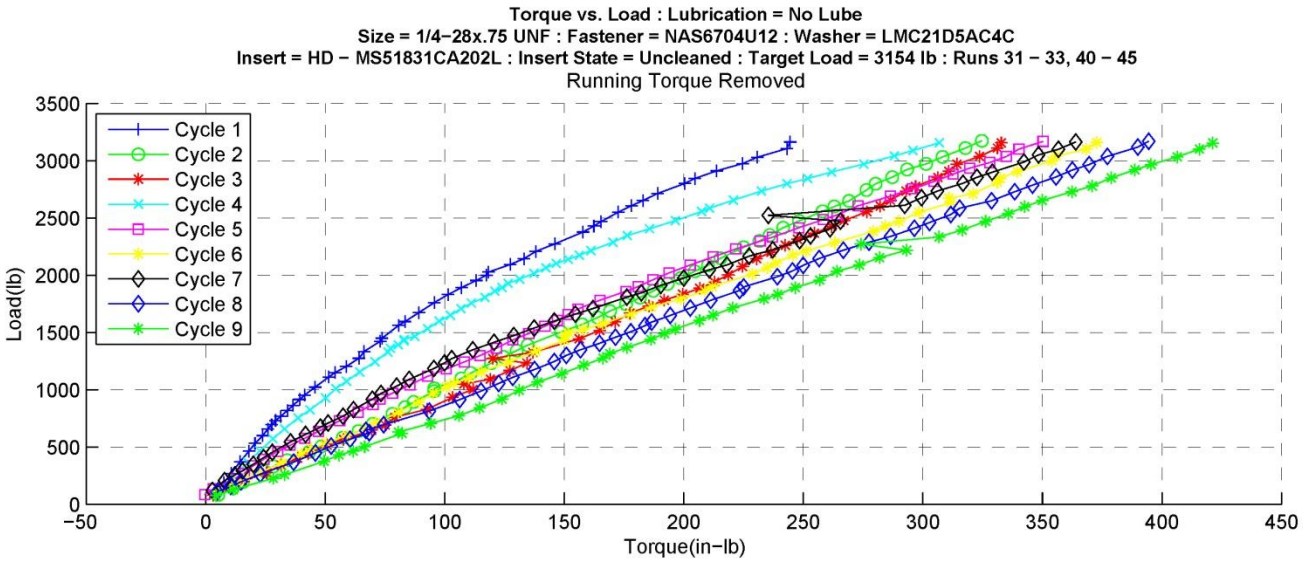

Torque vs. Load : Lubrication = No Lube
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = ExHD − MS51832CA202L : Insert State = Uncleaned : Target Load = 3154 lb : Runs 7 − 12
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

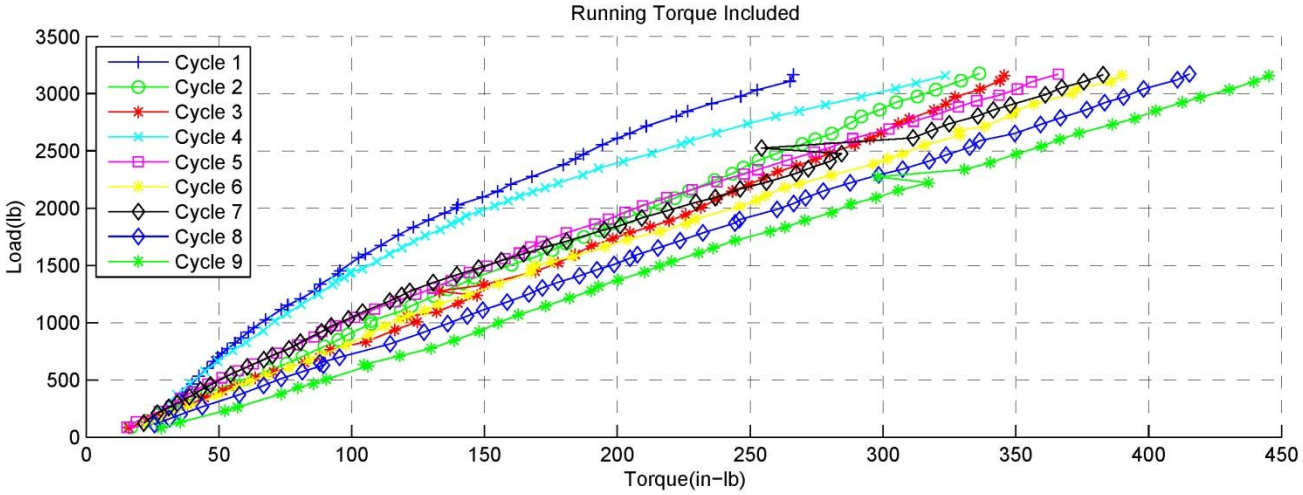

Torque vs. Load : Lubrication = No Lube
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = ExHD − MS51832CA202L : Insert State = Uncleaned : Target Load = 3154 lb : Runs 13 − 18
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300
350
400
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

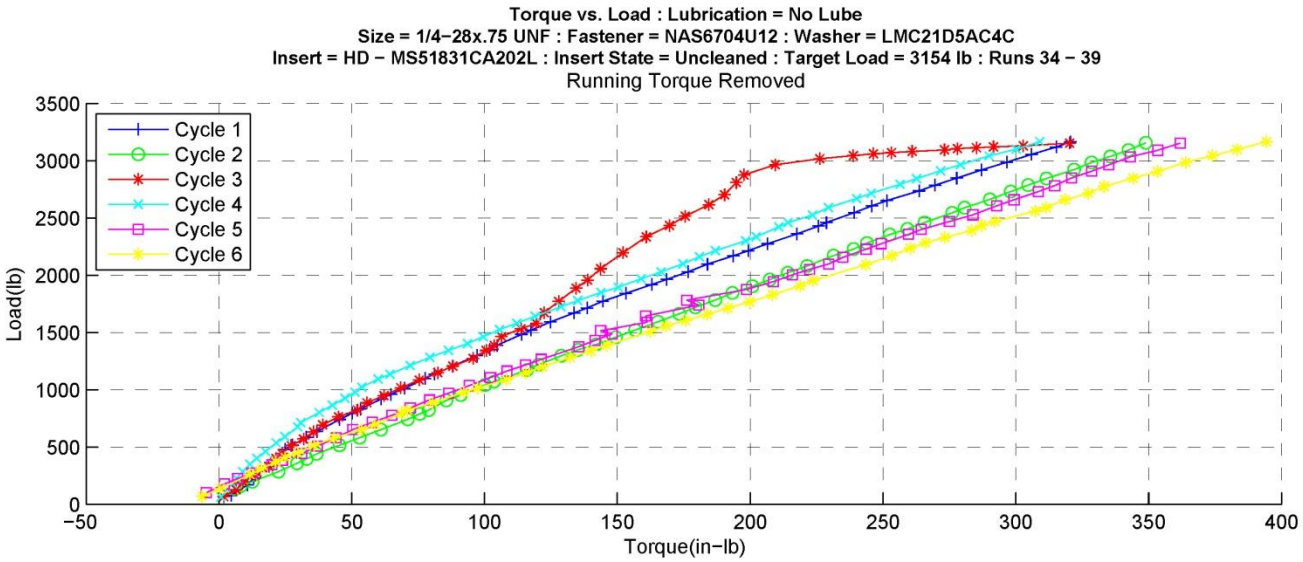

Torque vs. Load : Lubrication = No Lube
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = HD − MS51831CA202L : Insert State = Cleaned : Target Load = 3154 lb : Runs 19 − 24
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

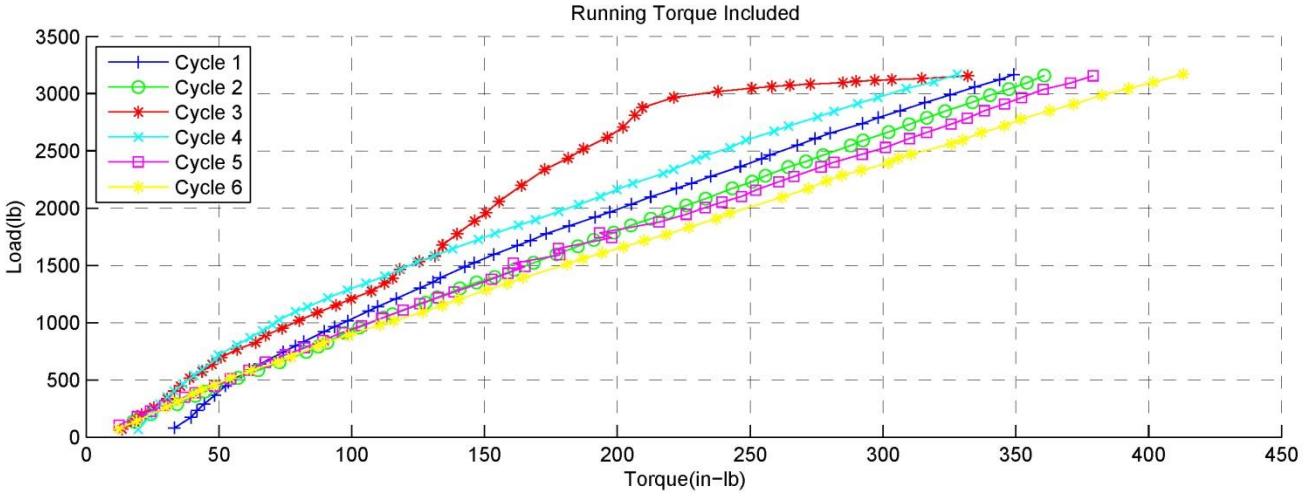

Torque vs. Load : Lubrication = No Lube
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = HD − MS51831CA202L : Insert State = Cleaned : Target Load = 3154 lb : Runs 25 − 30
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)


Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)


Torque vs. Load : Lubrication = No Lube
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = HD − MS51831CA202L : Insert State = Uncleaned : Target Load = 3154 lb : Runs 31 − 33, 40 − 45
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Cycle 7
Cycle 8
Cycle 9
Load(lb)
Torque(in−lb)

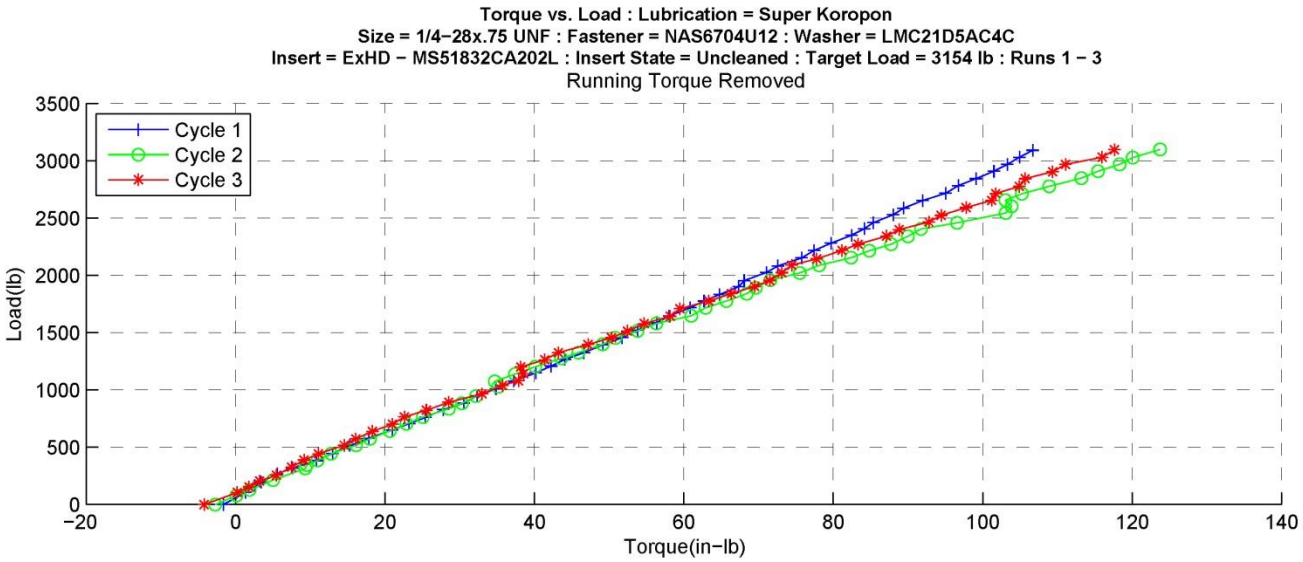

Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Cycle 7
Cycle 8
Cycle 9
Load(lb)
Torque(in−lb)

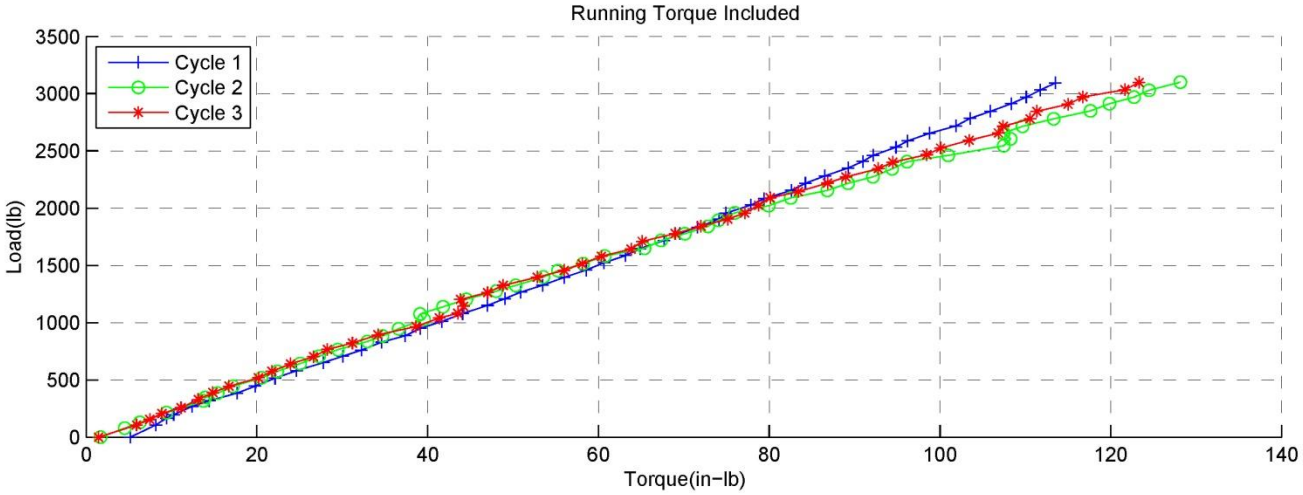

Torque vs. Load : Lubrication = No Lube
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = HD − MS51831CA202L : Insert State = Uncleaned : Target Load = 3154 lb : Runs 34 − 39
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
−50
0
50
100
150
200
250
300
350
400

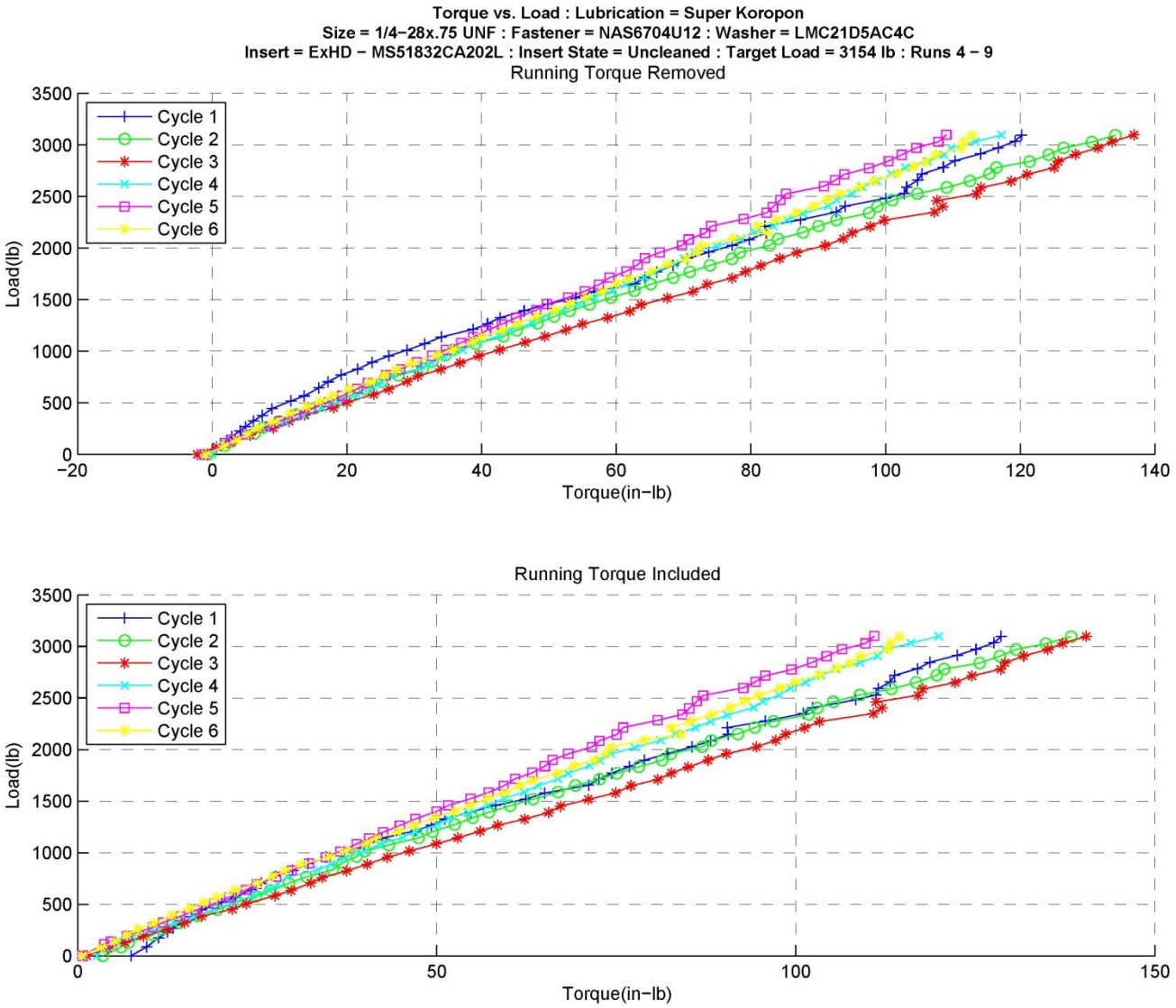

Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300
350
400
450

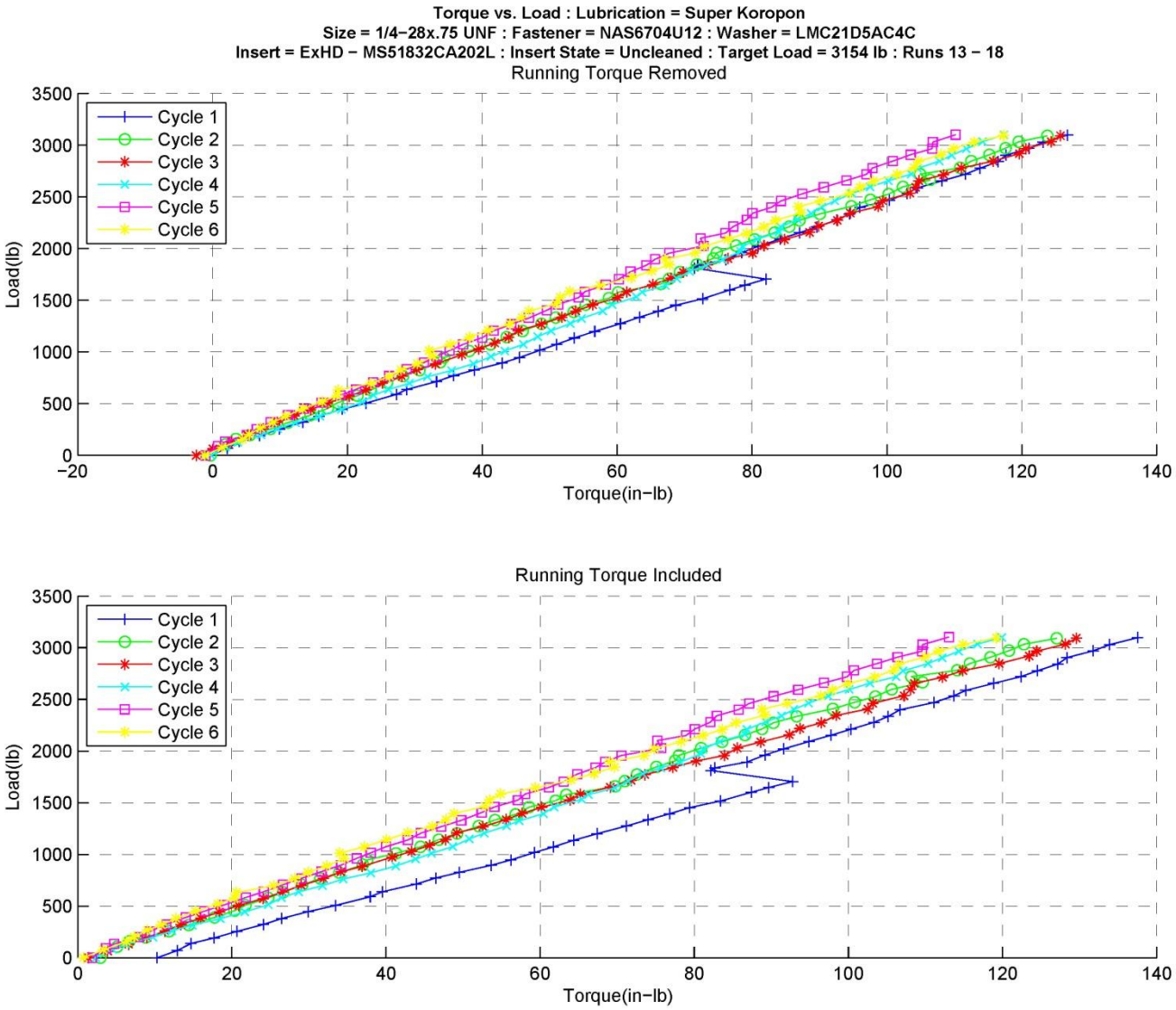
Appendix B:

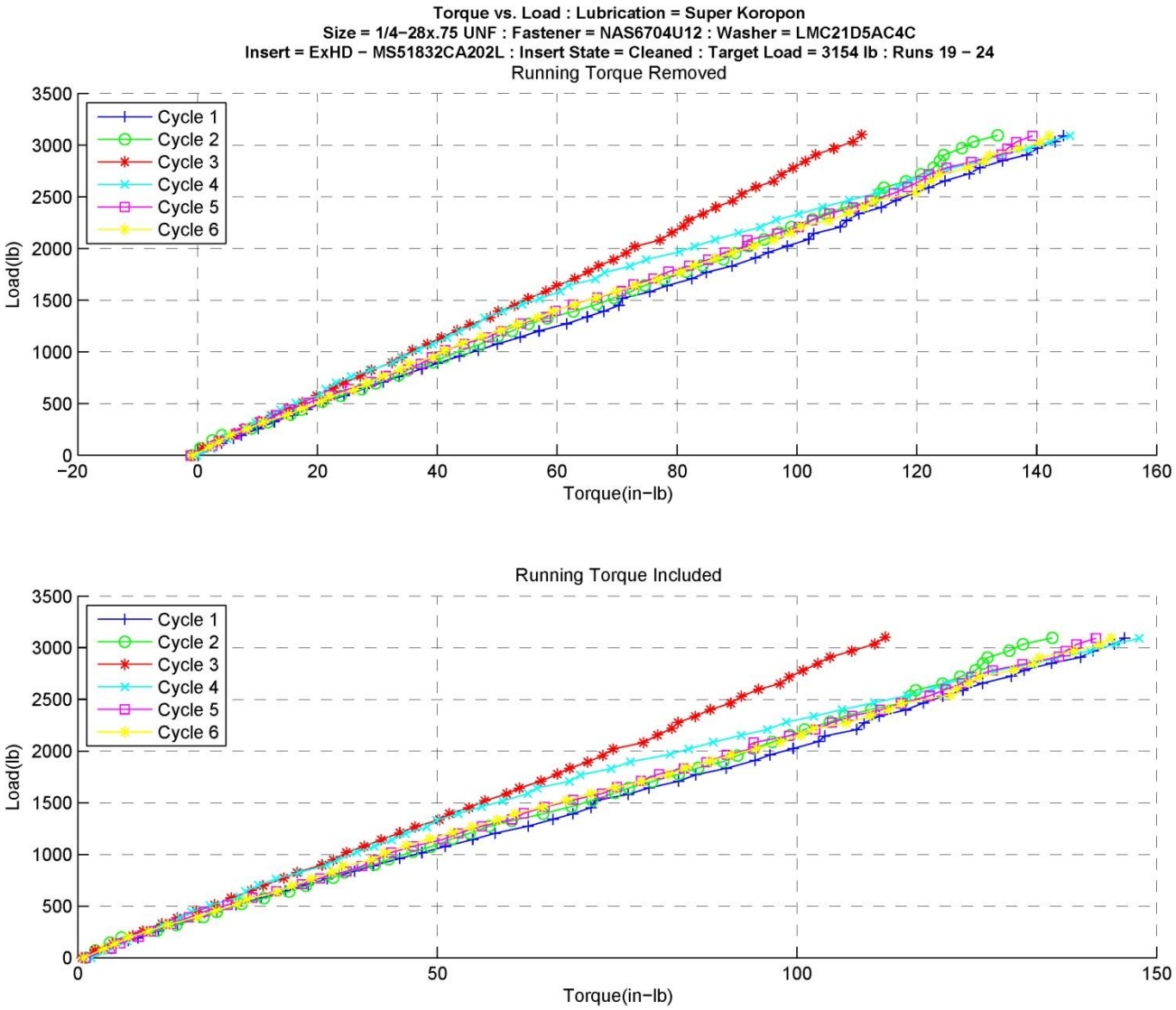
Section 1	¼-28 Dry Torque Tension Plots
Section 2	¼-28 Wet Torque Tension Plots
Section 3	¼-28 Dry Running Torque Plots
Section 4	¼-28 Wet Running Torque Plots
Section 5	¼-28 Dry Cycle Plots: Torque vs. Load
Section 6	¼-28 Wet Cycle Plots: Torque vs. Load
Section 7	¼-28 Friction Coefficients
Section 8	¼-28 Test Plate Layouts
Section 9	¼-28 Dry Run Logs
Section 10	¼-28 Wet Run Logs

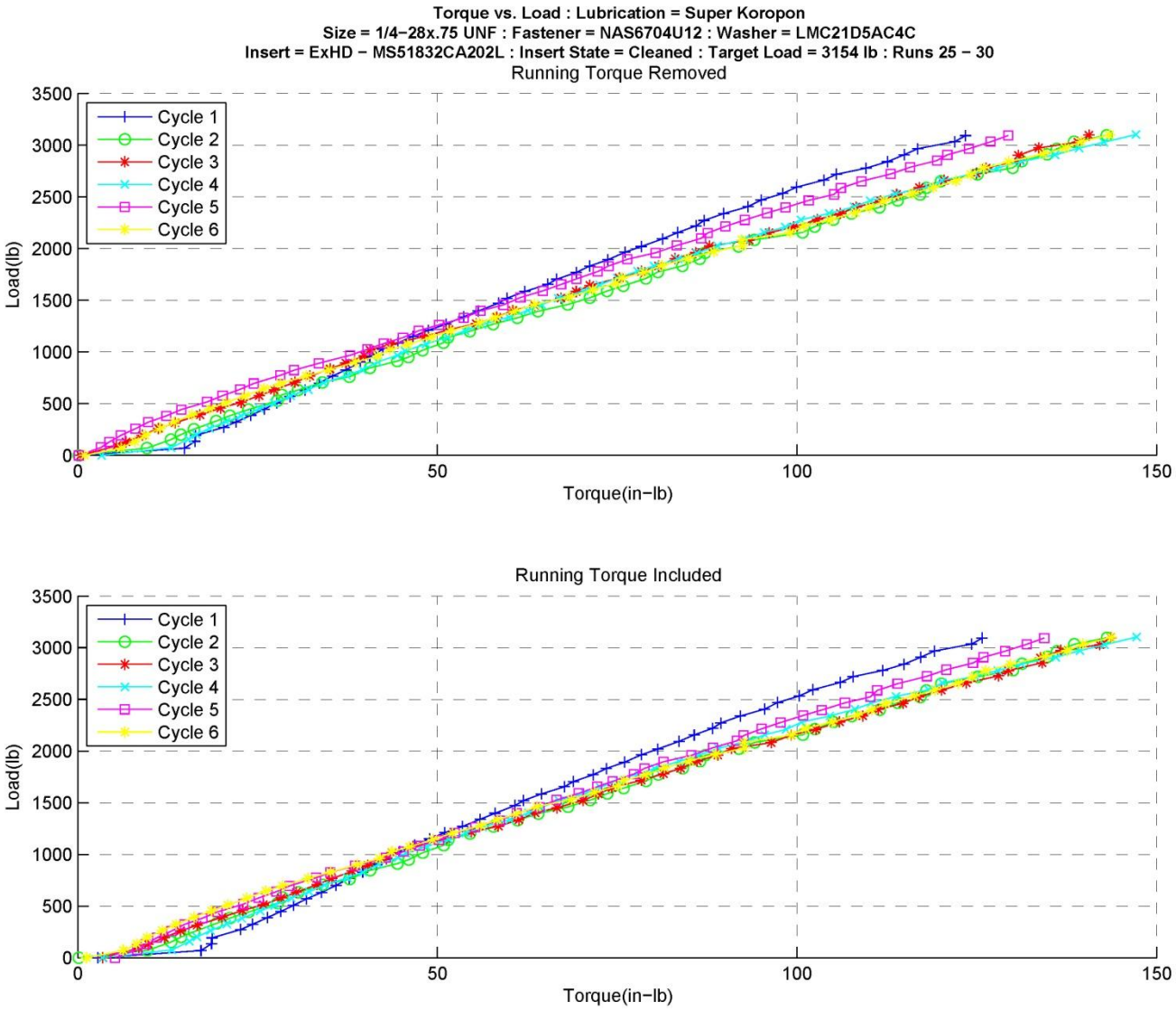

Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = ExHD − MS51832CA202L : Insert State = Uncleaned : Target Load = 3154 lb : Runs 1 − 3
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
−20
0
20
40
60
80
100
120
140

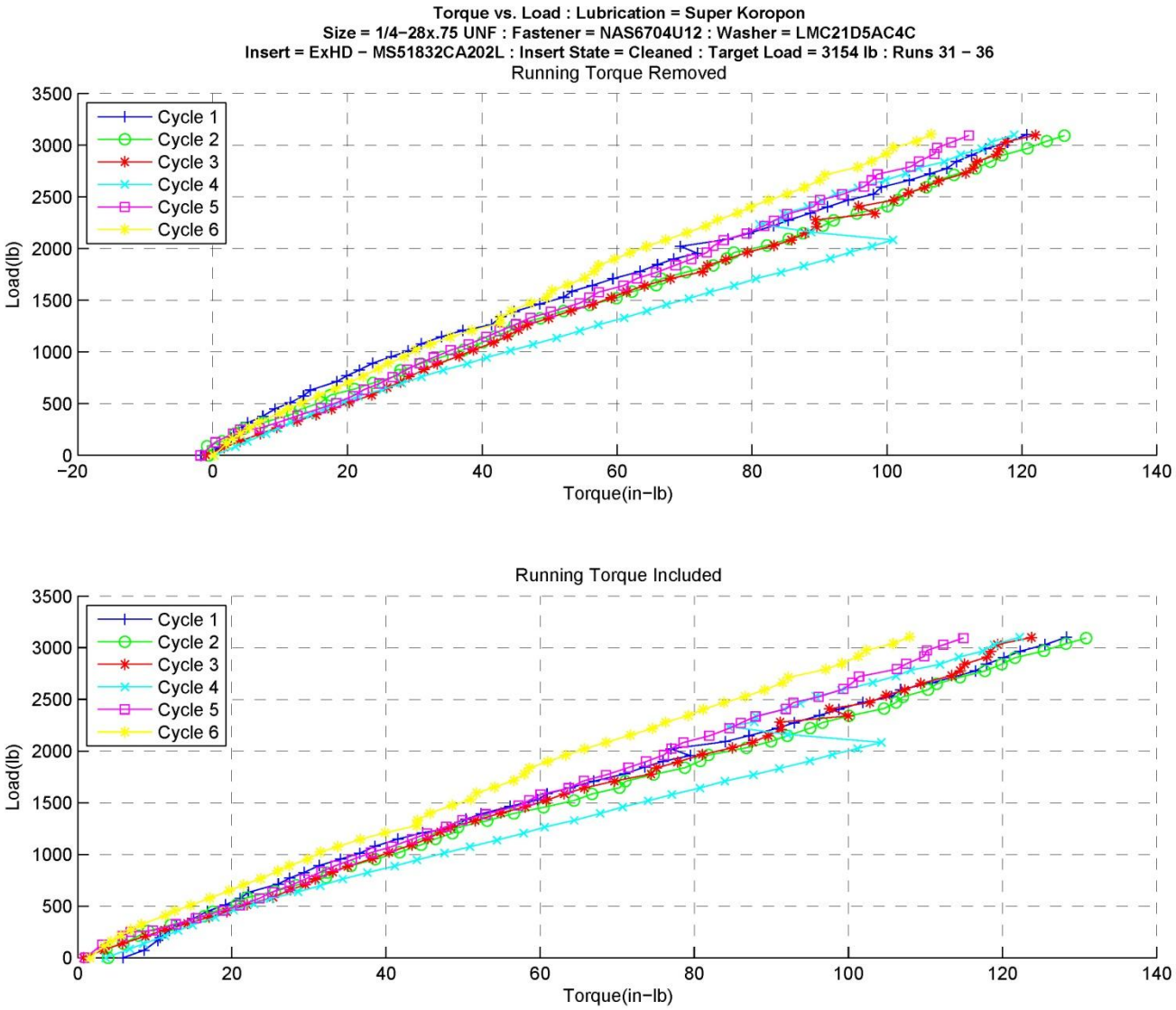

Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
120
140

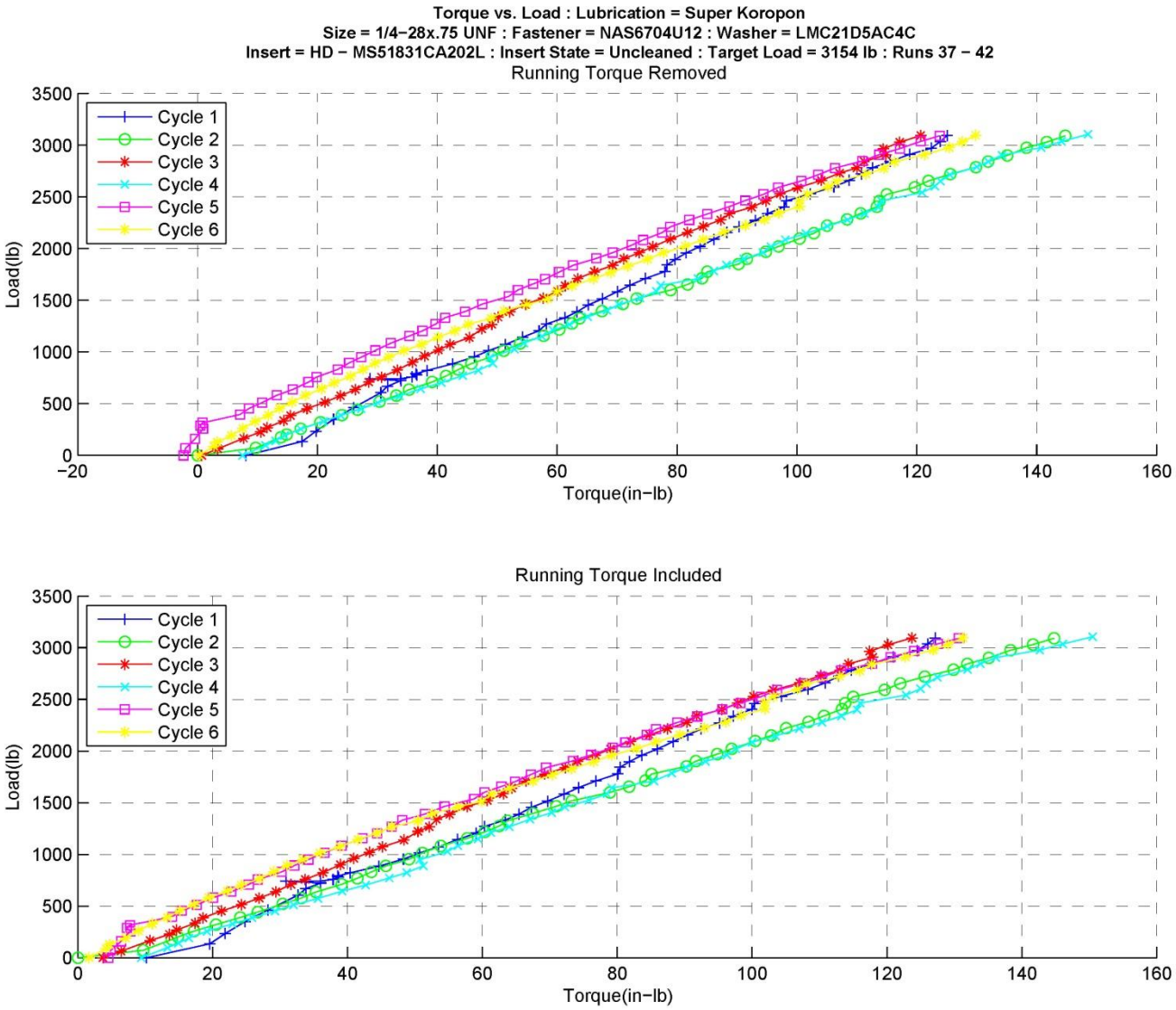

Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = ExHD − MS51832CA202L : Insert State = Uncleaned : Target Load = 3154 lb : Runs 4 − 9
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

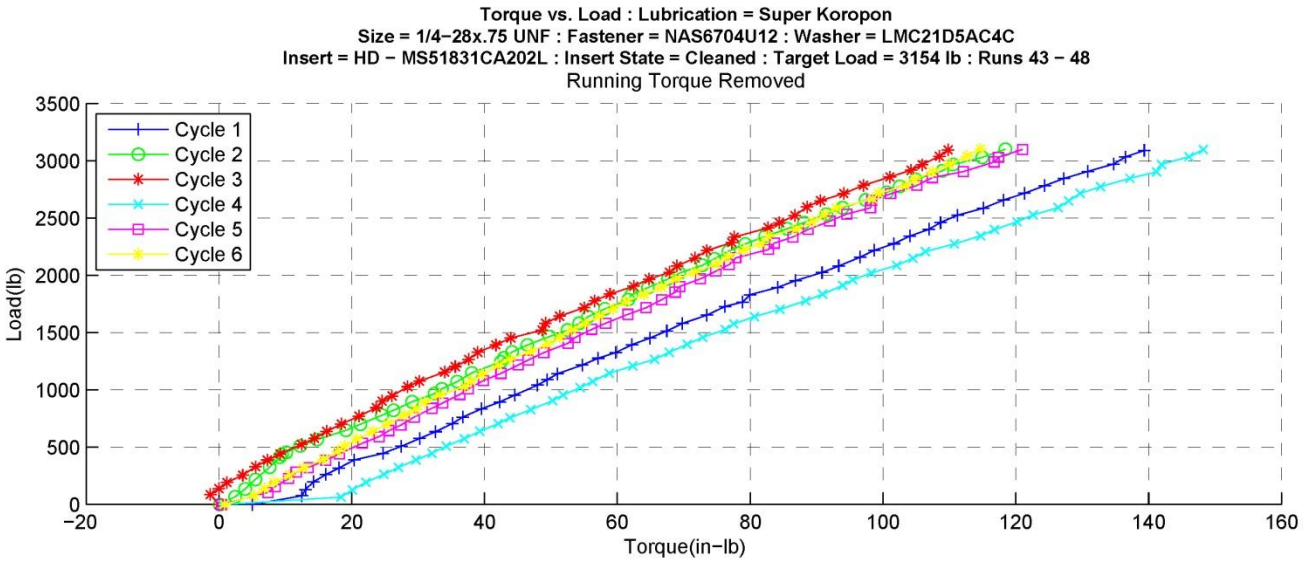

Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = ExHD − MS51832CA202L : Insert State = Uncleaned : Target Load = 3154 lb : Runs 13 − 18
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

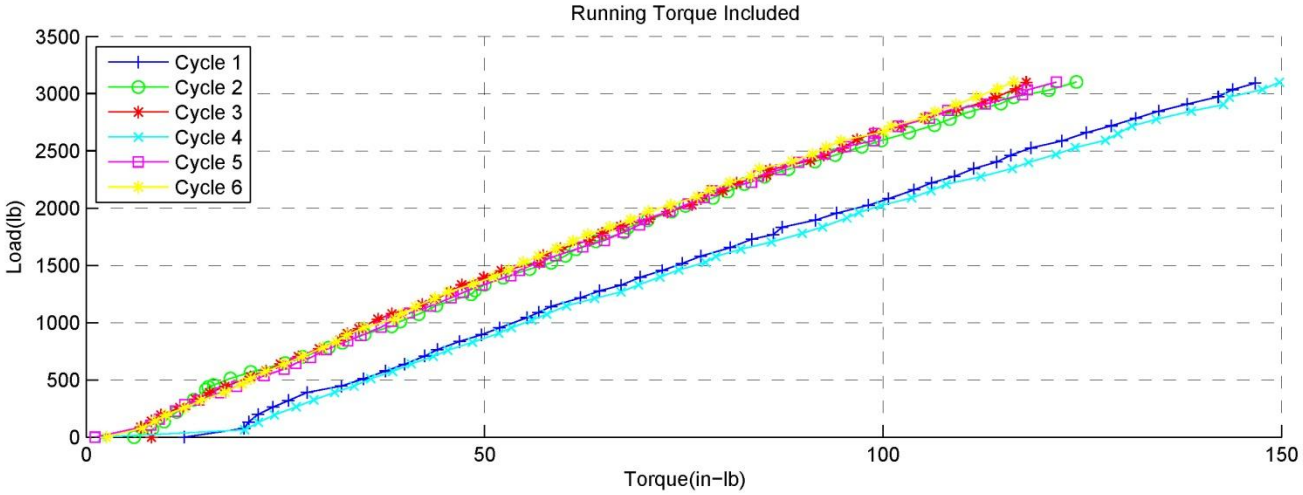

Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = ExHD − MS51832CA202L : Insert State = Cleaned : Target Load = 3154 lb : Runs 19 − 24
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

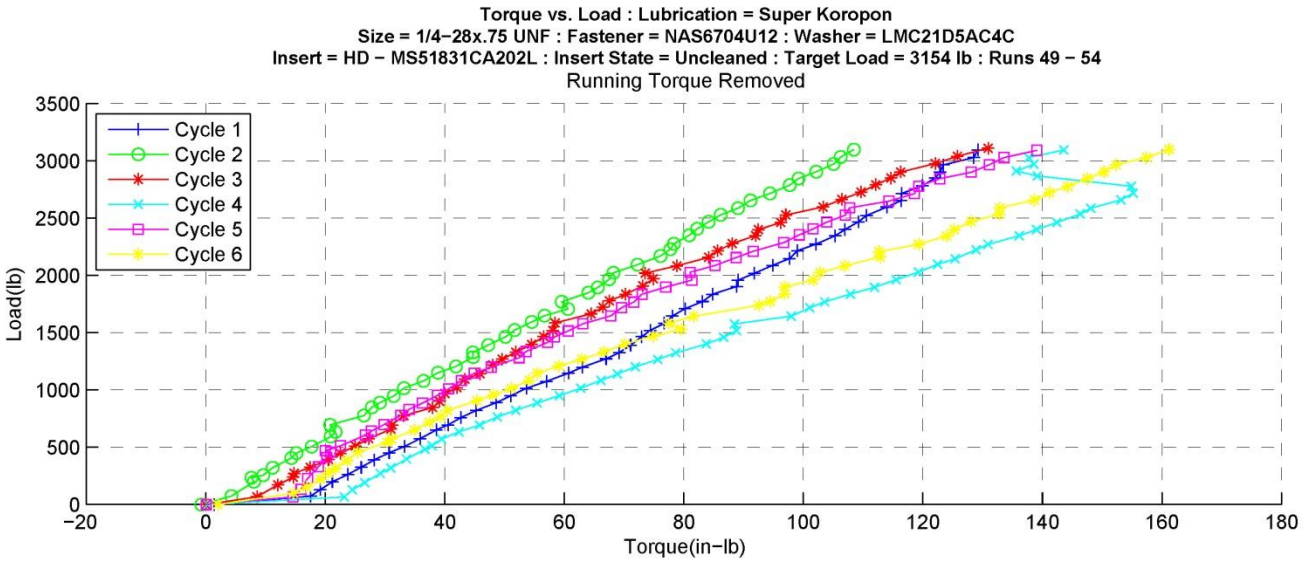

Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = ExHD − MS51832CA202L : Insert State = Cleaned : Target Load = 3154 lb : Runs 25 − 30
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

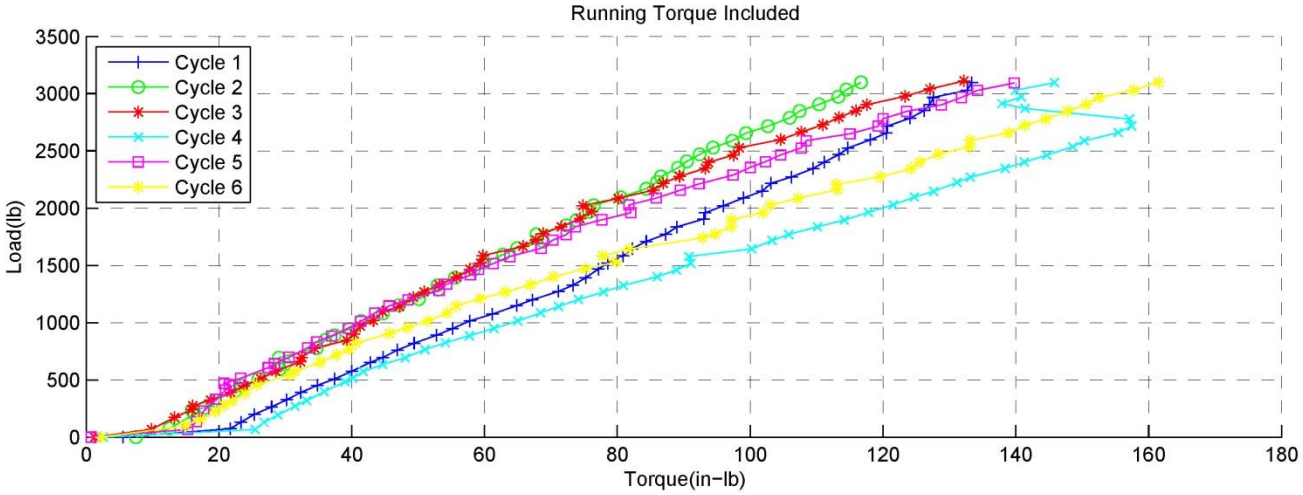

Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = ExHD − MS51832CA202L : Insert State = Cleaned : Target Load = 3154 lb : Runs 31 − 36
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

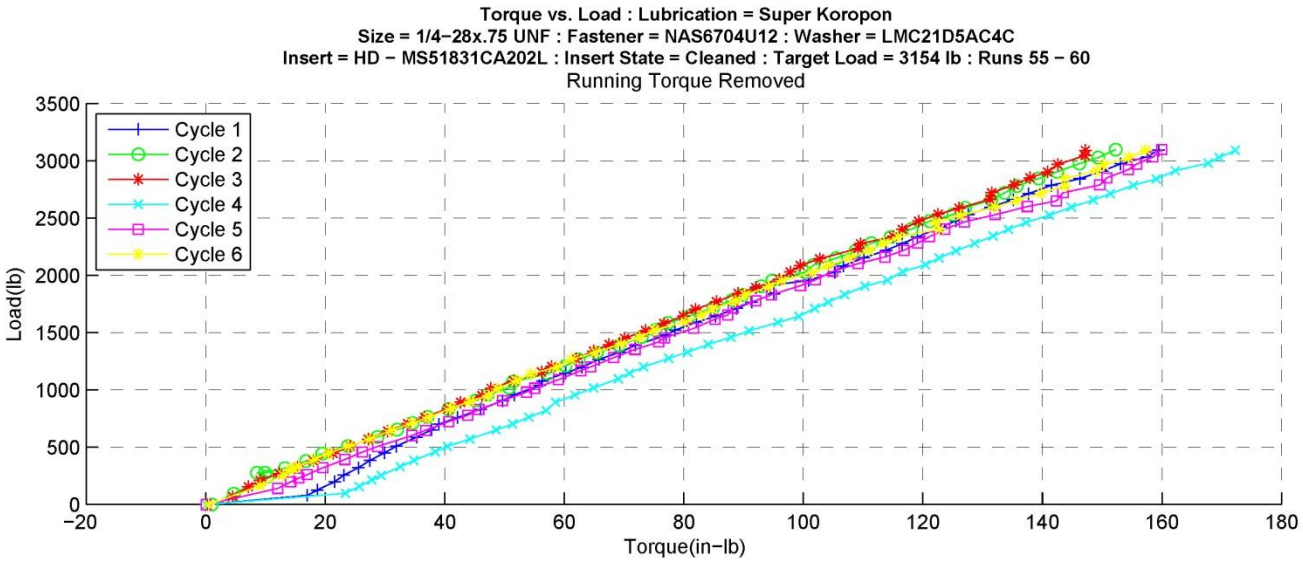

Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = HD − MS51831CA202L : Insert State = Uncleaned : Target Load = 3154 lb : Runs 37 − 42
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

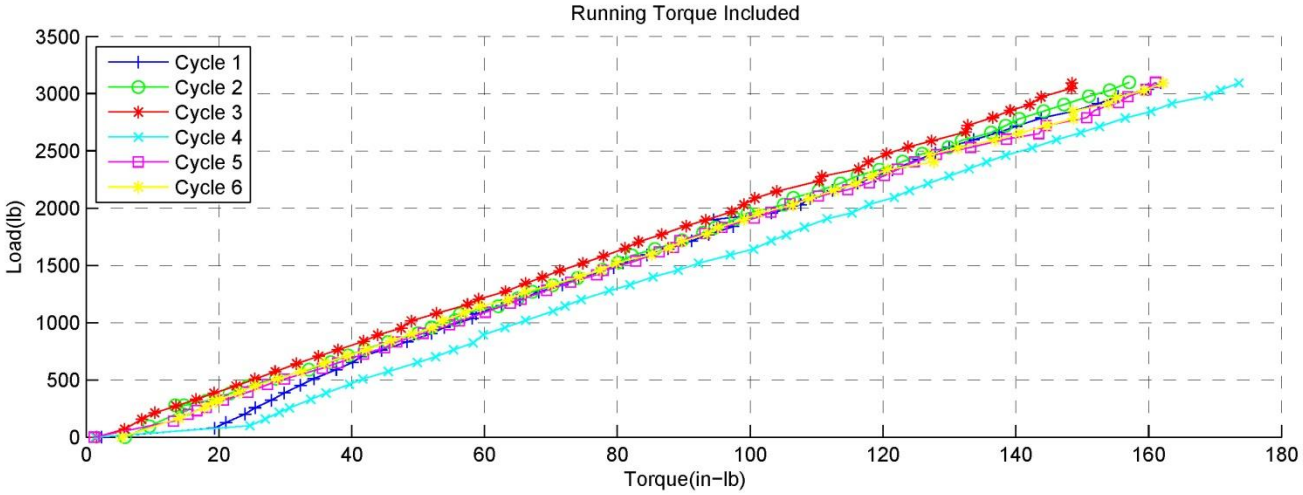

Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = HD − MS51831CA202L : Insert State = Cleaned : Target Load = 3154 lb : Runs 43 − 48
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
−20
0
20
40
60
80
100
120
140
160

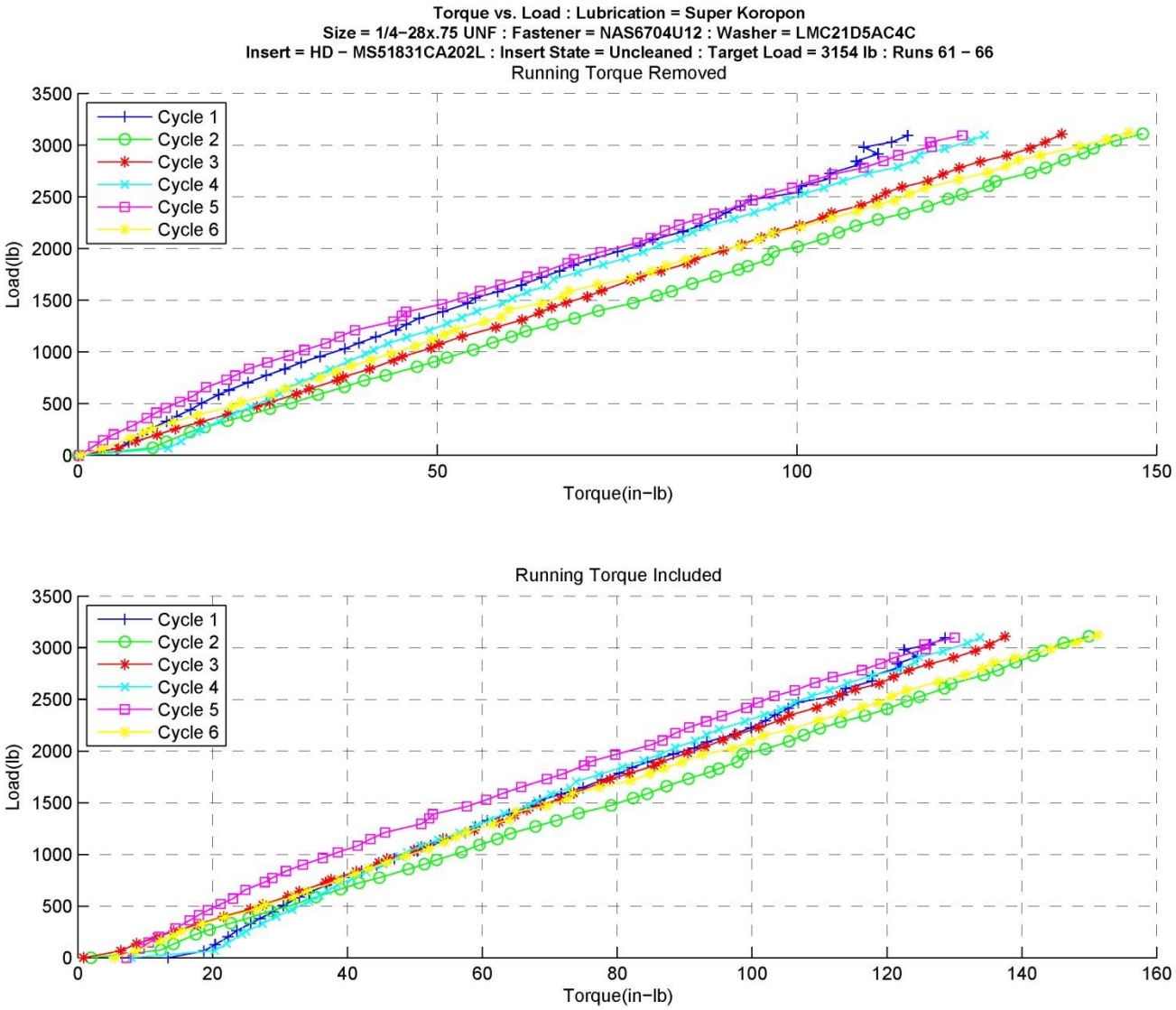

Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
0
50
100
150

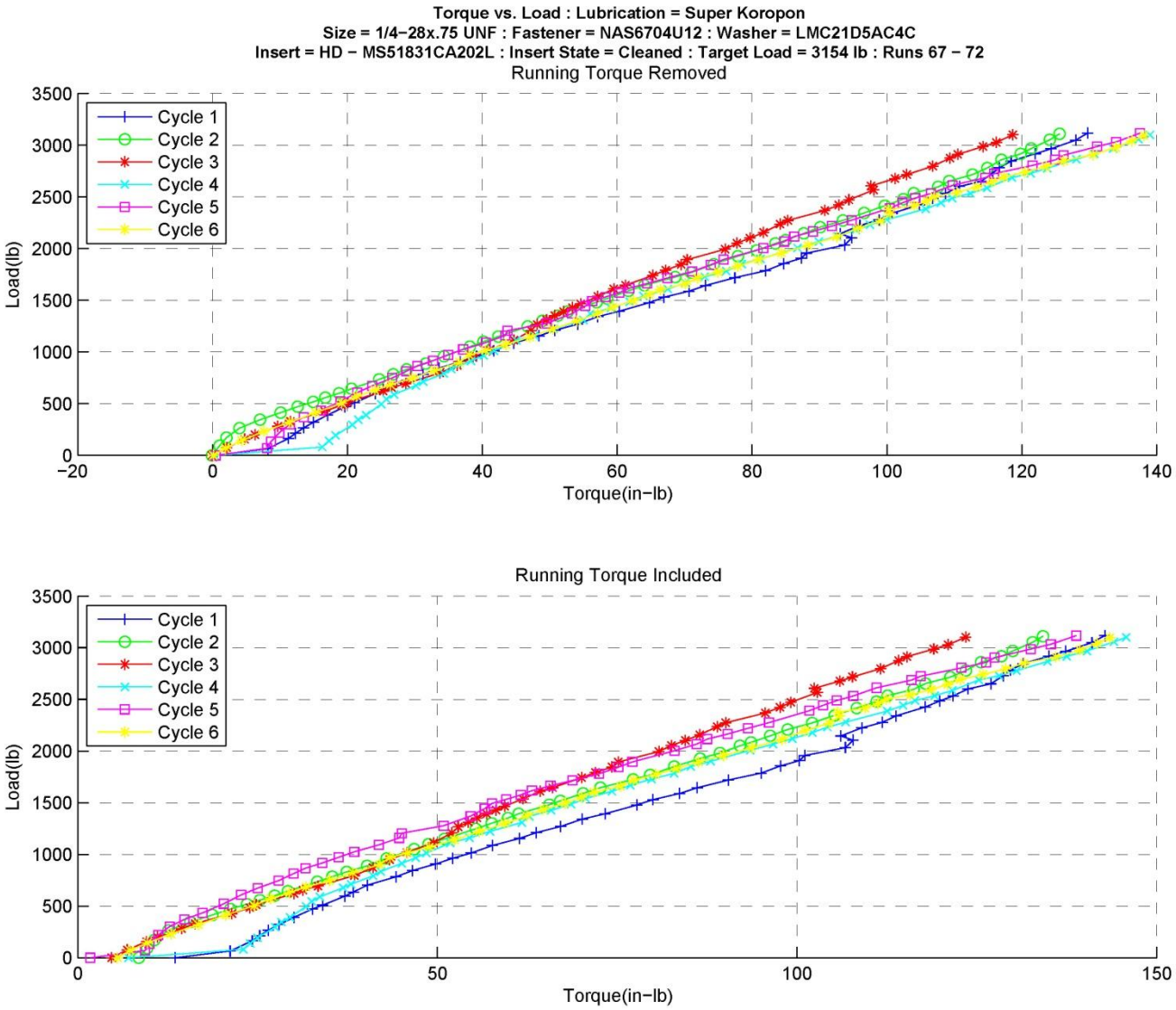

Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = HD − MS51831CA202L : Insert State = Uncleaned : Target Load = 3154 lb : Runs 49 − 54
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
−20
0
20
40
60
80
100
120
140
160
180

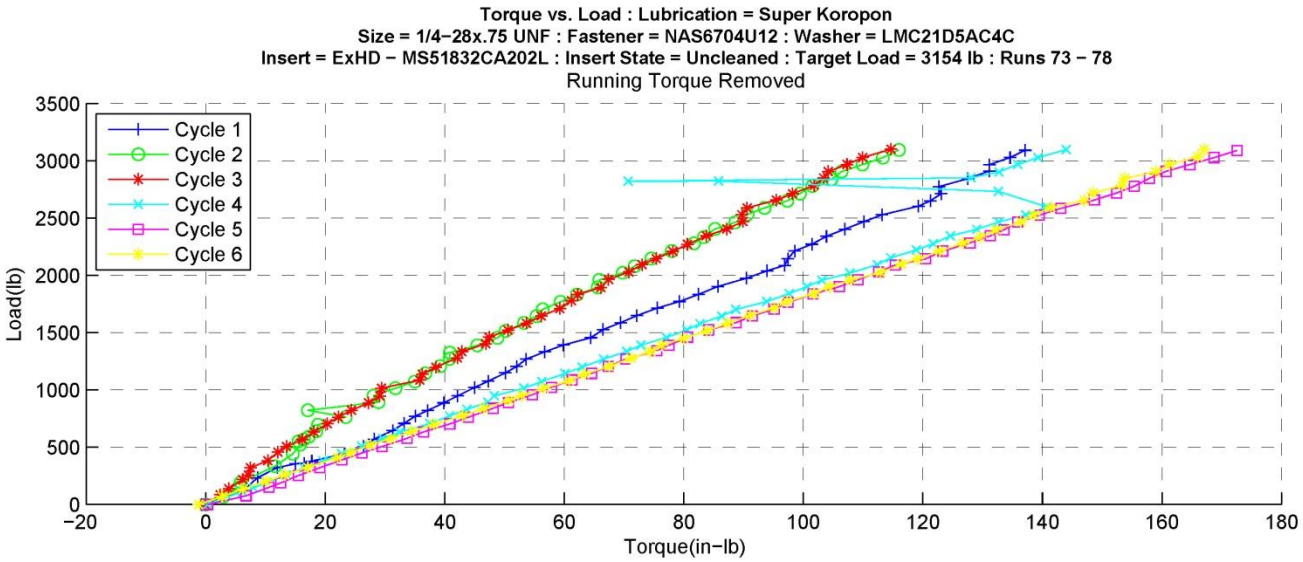

Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
120
140
160
180

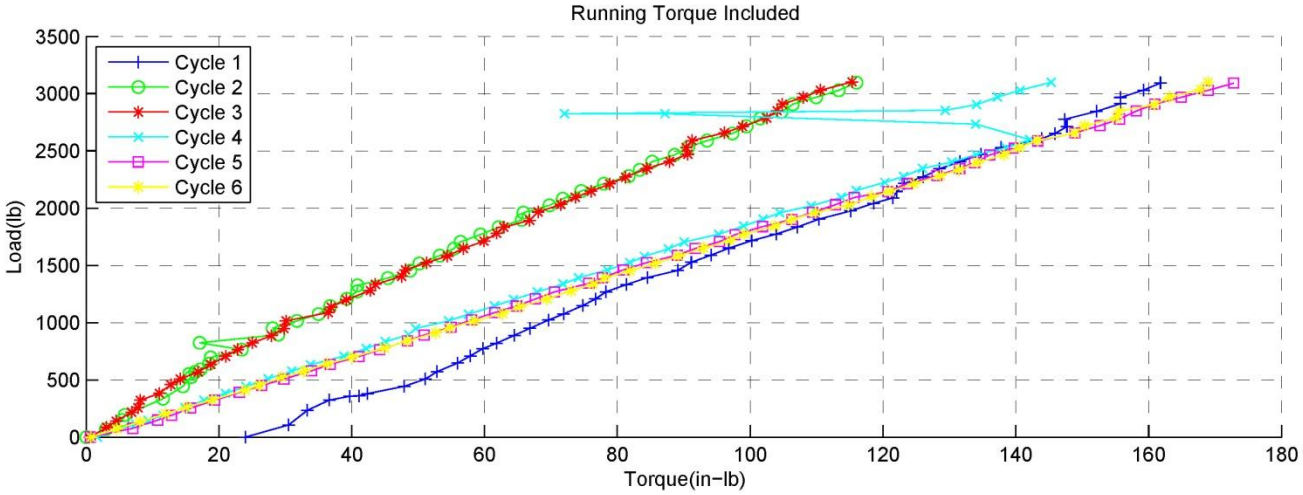

Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = HD − MS51831CA202L : Insert State = Cleaned : Target Load = 3154 lb : Runs 55 − 60
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

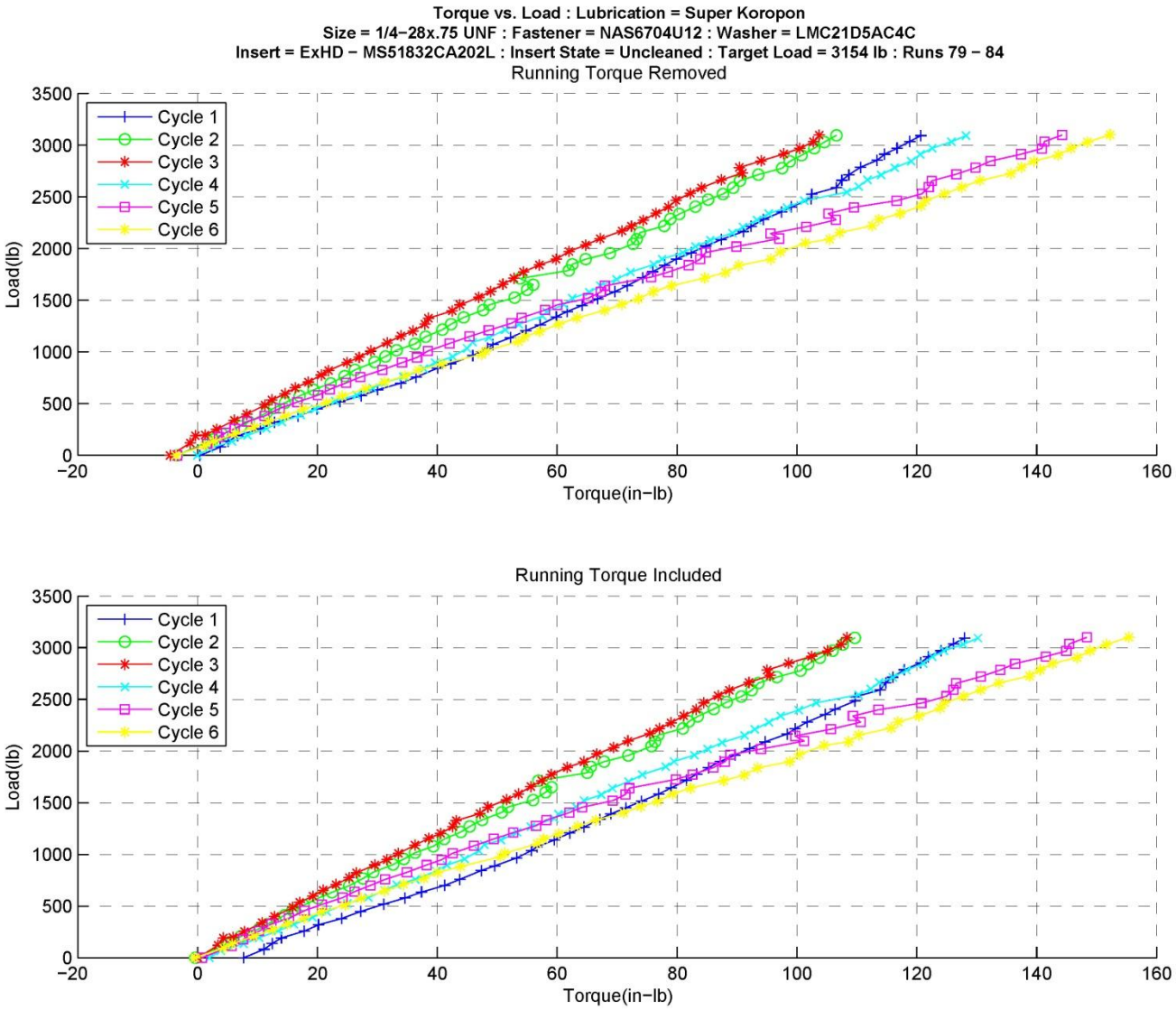

Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

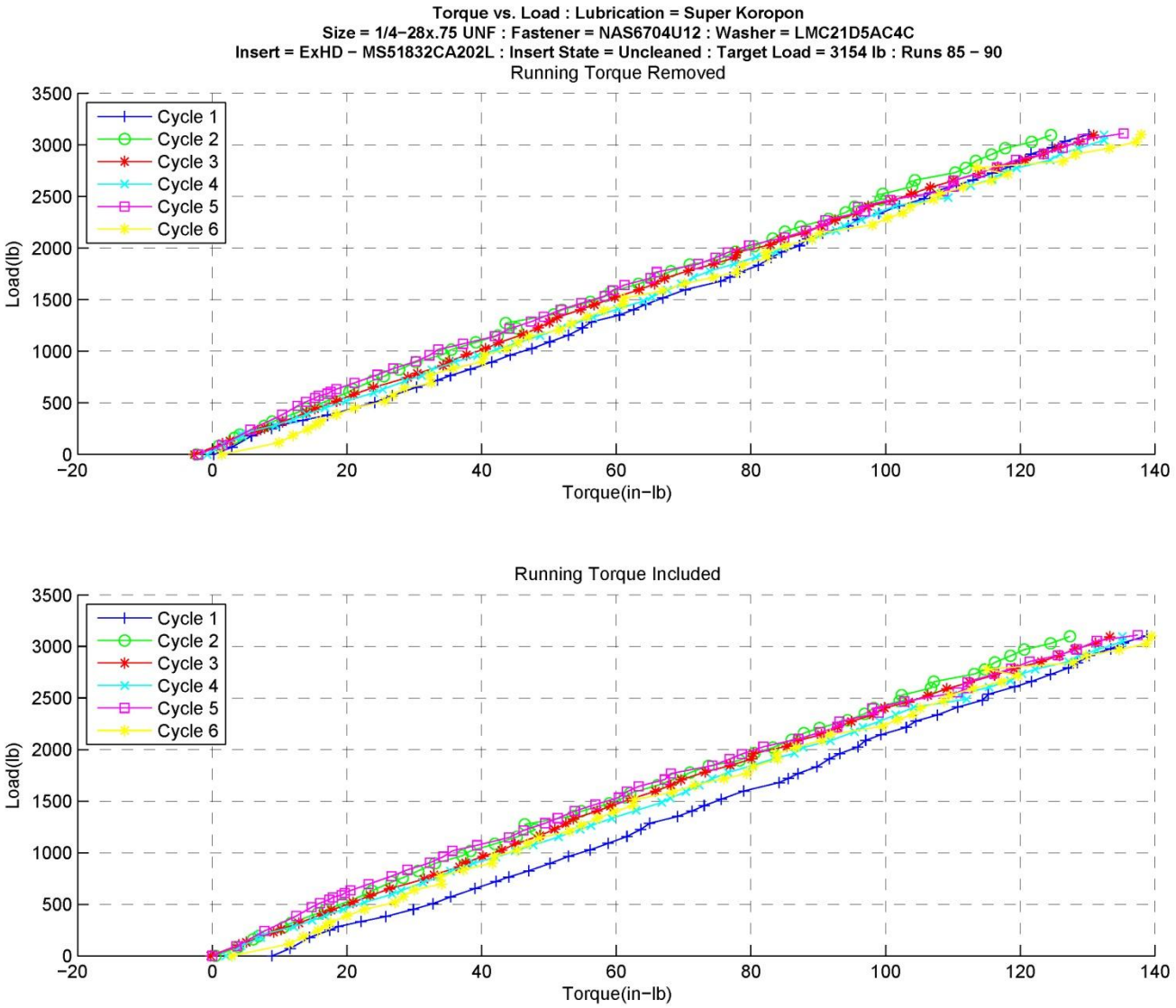

Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = HD − MS51831CA202L : Insert State = Uncleaned : Target Load = 3154 lb : Runs 61 − 66
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
20
40
60
80
100
120
140
160

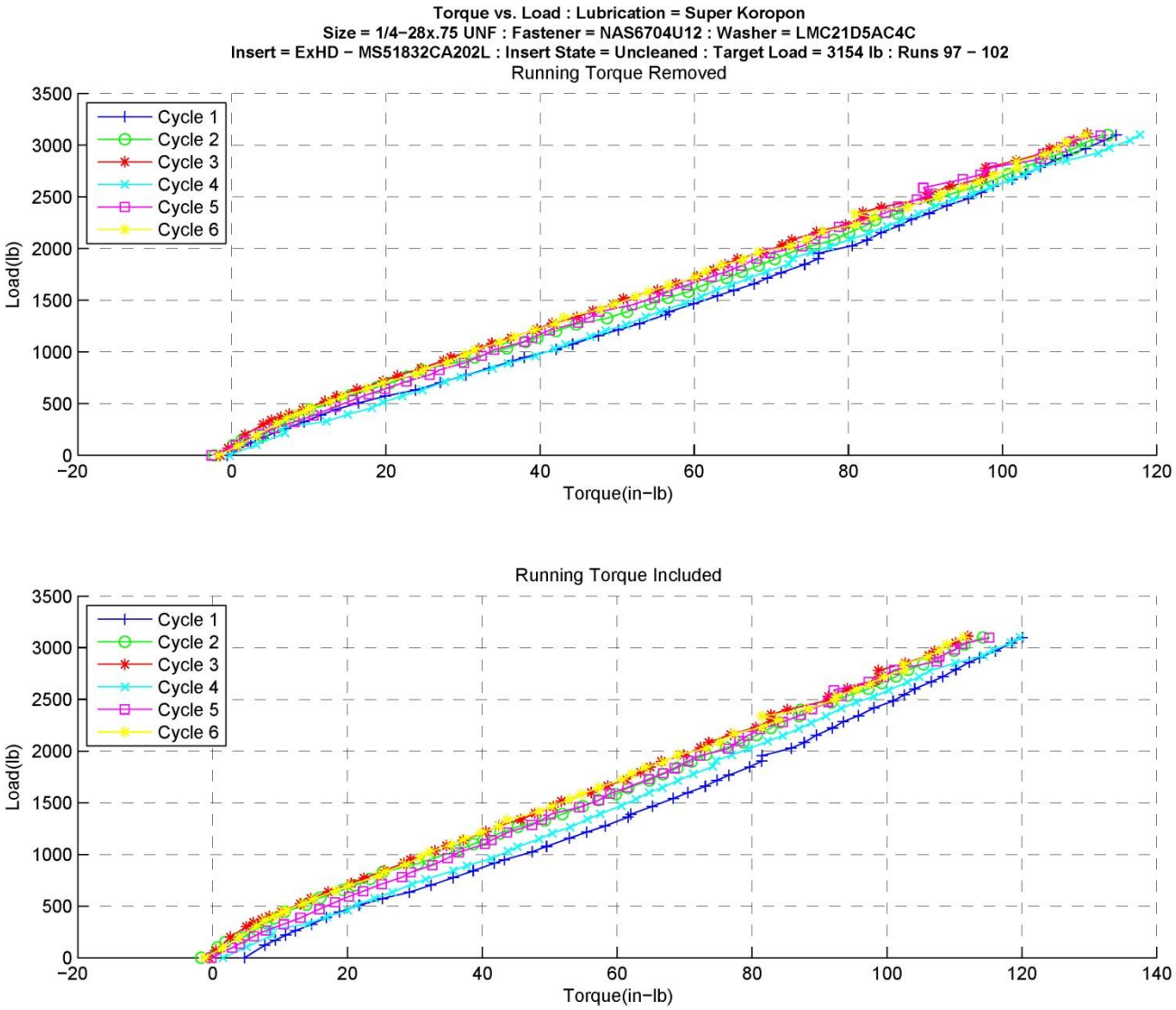

Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = HD − MS51831CA202L : Insert State = Cleaned : Target Load = 3154 lb : Runs 67 − 72
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

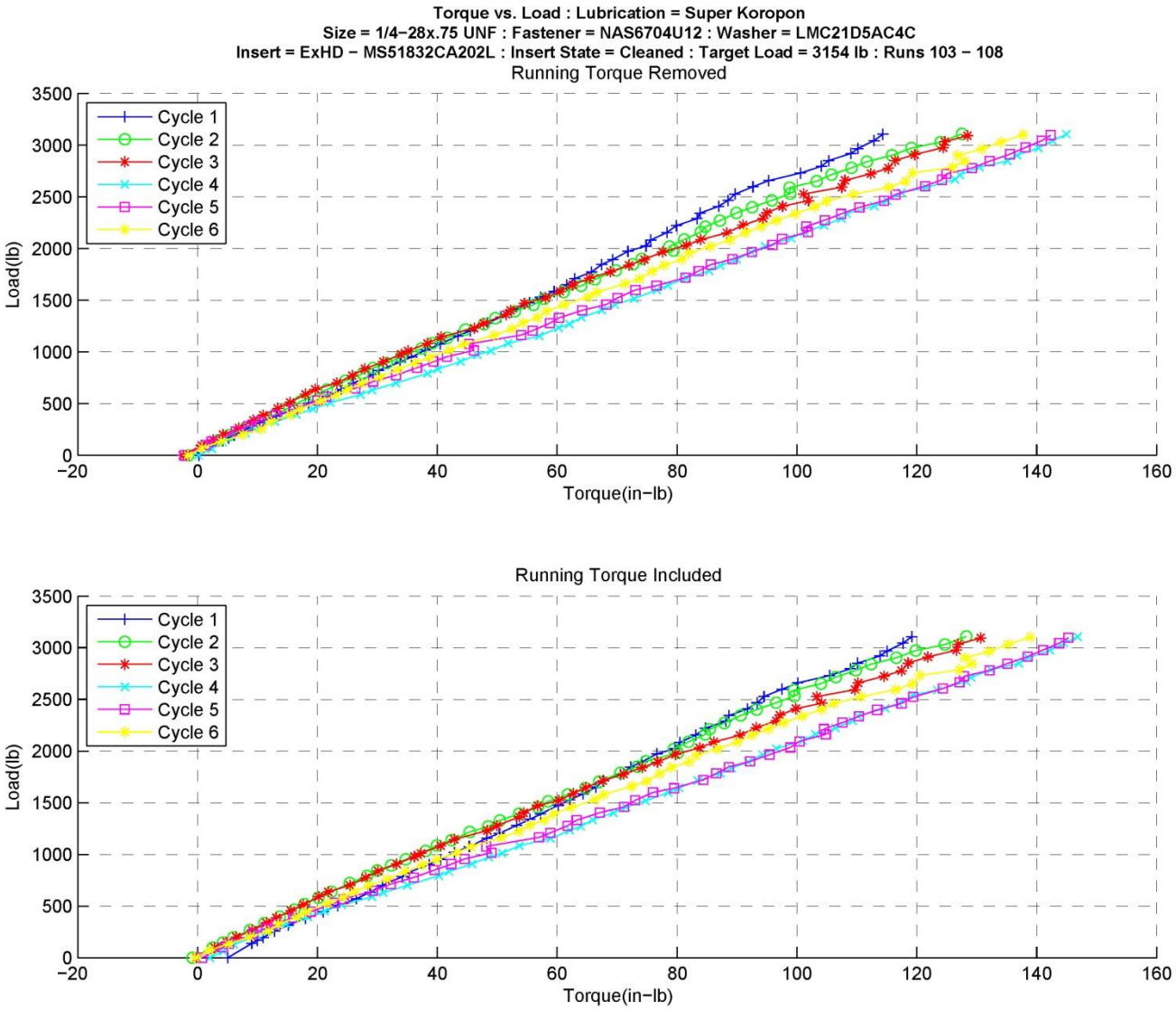

Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = ExHD − MS51832CA202L : Insert State = Uncleaned : Target Load = 3154 lb : Runs 73 − 78
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

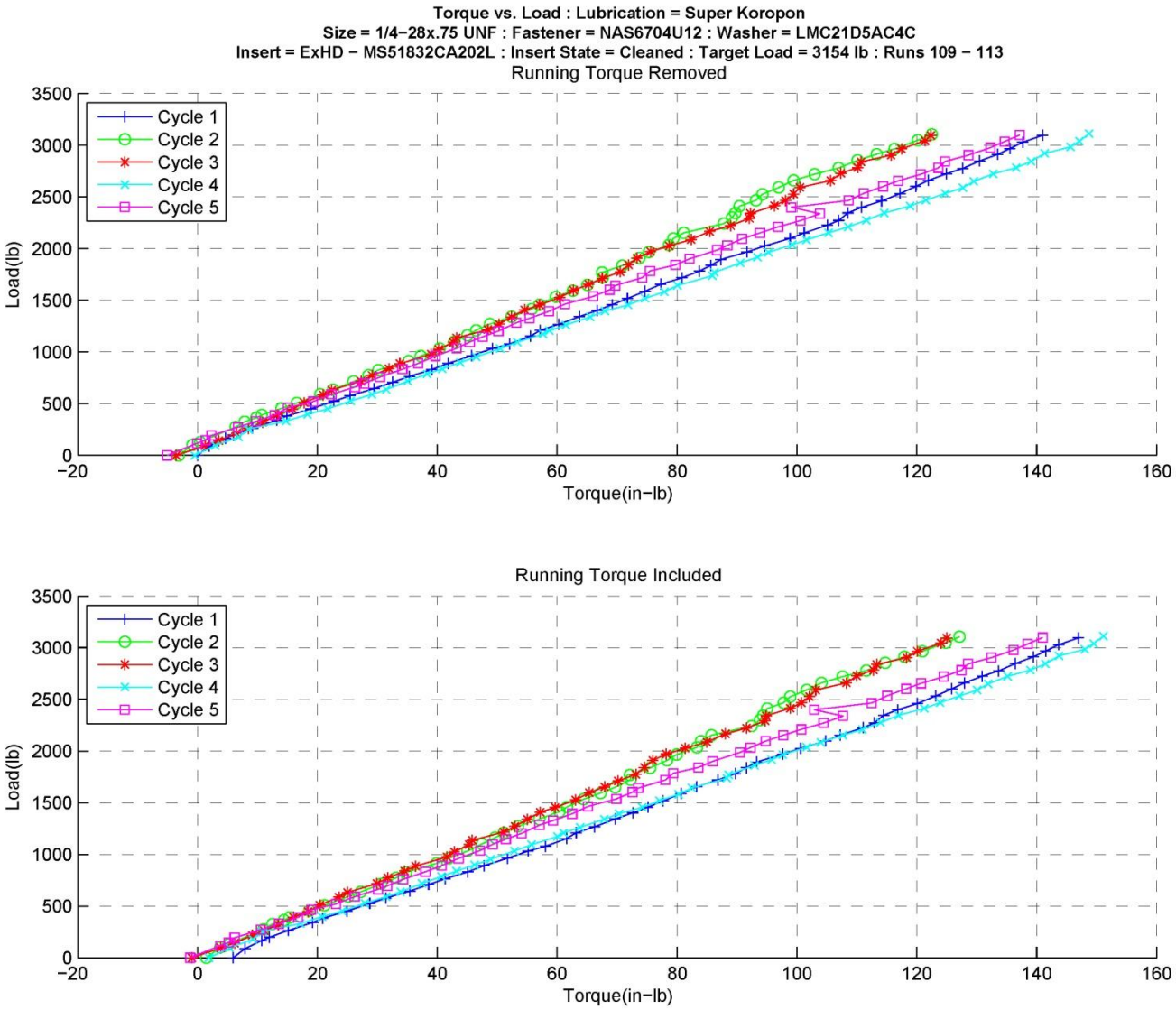

Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

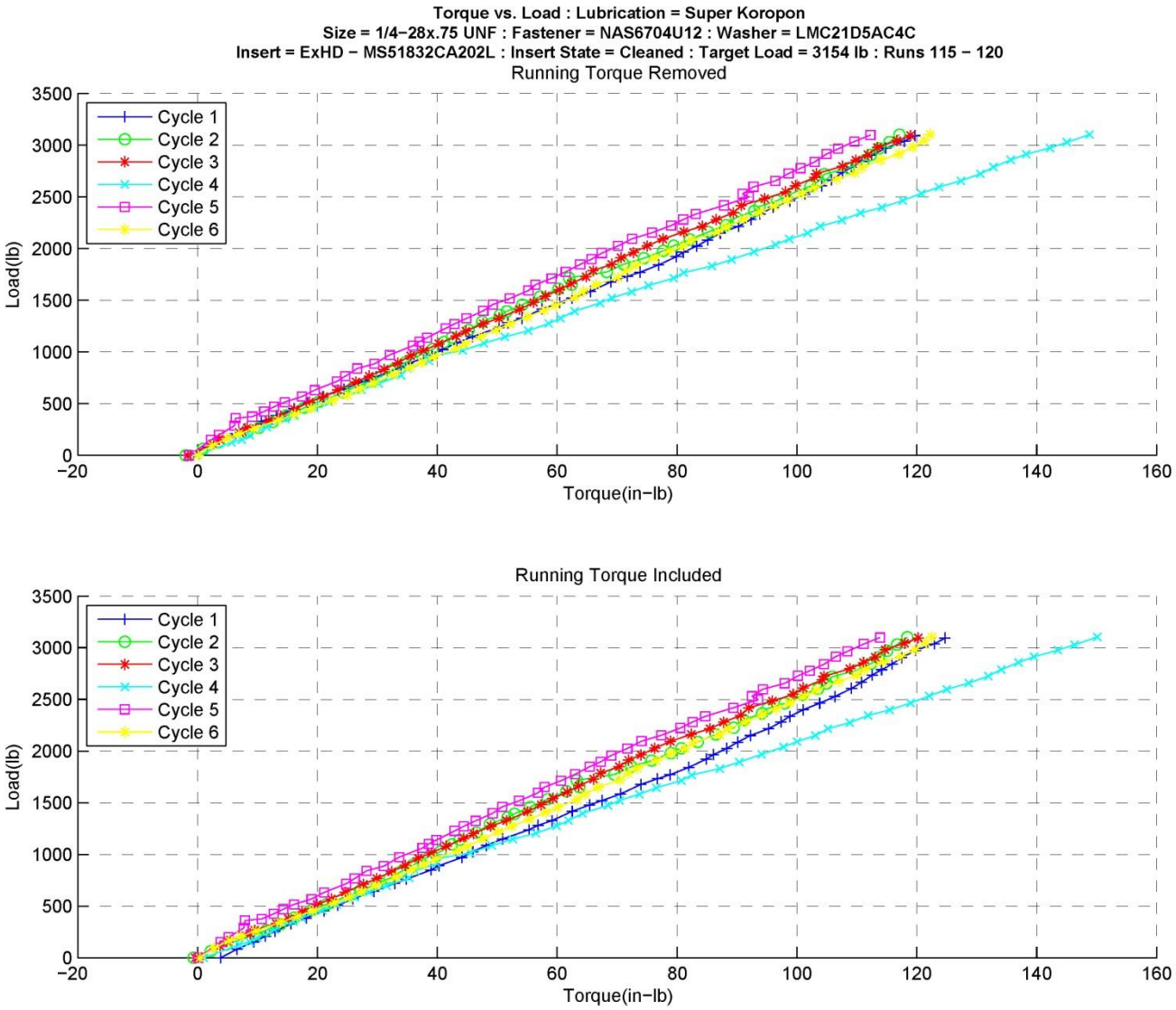

Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = ExHD − MS51832CA202L : Insert State = Uncleaned : Target Load = 3154 lb : Runs 79 − 84
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

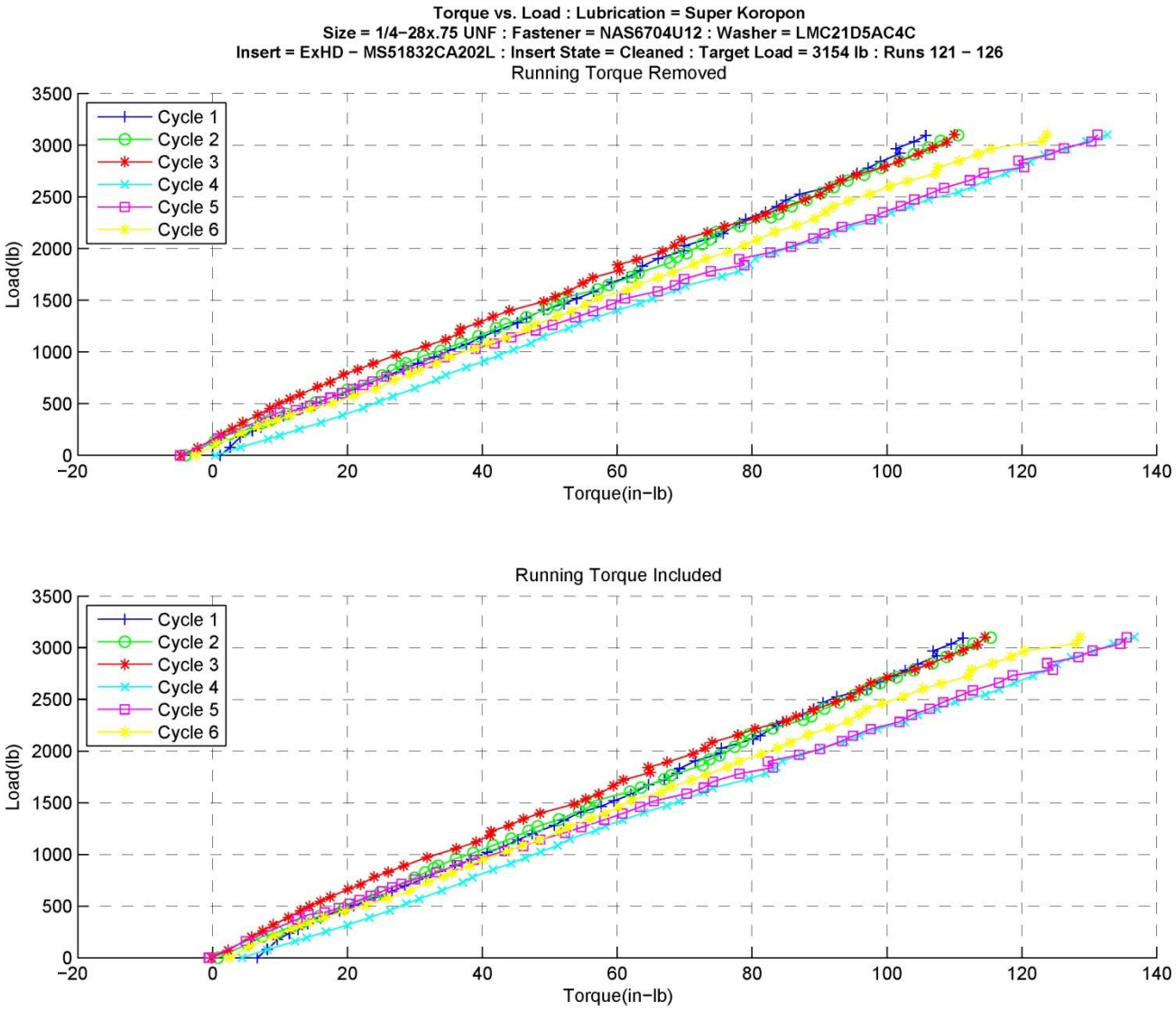

Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = ExHD − MS51832CA202L : Insert State = Uncleaned : Target Load = 3154 lb : Runs 85 − 90
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

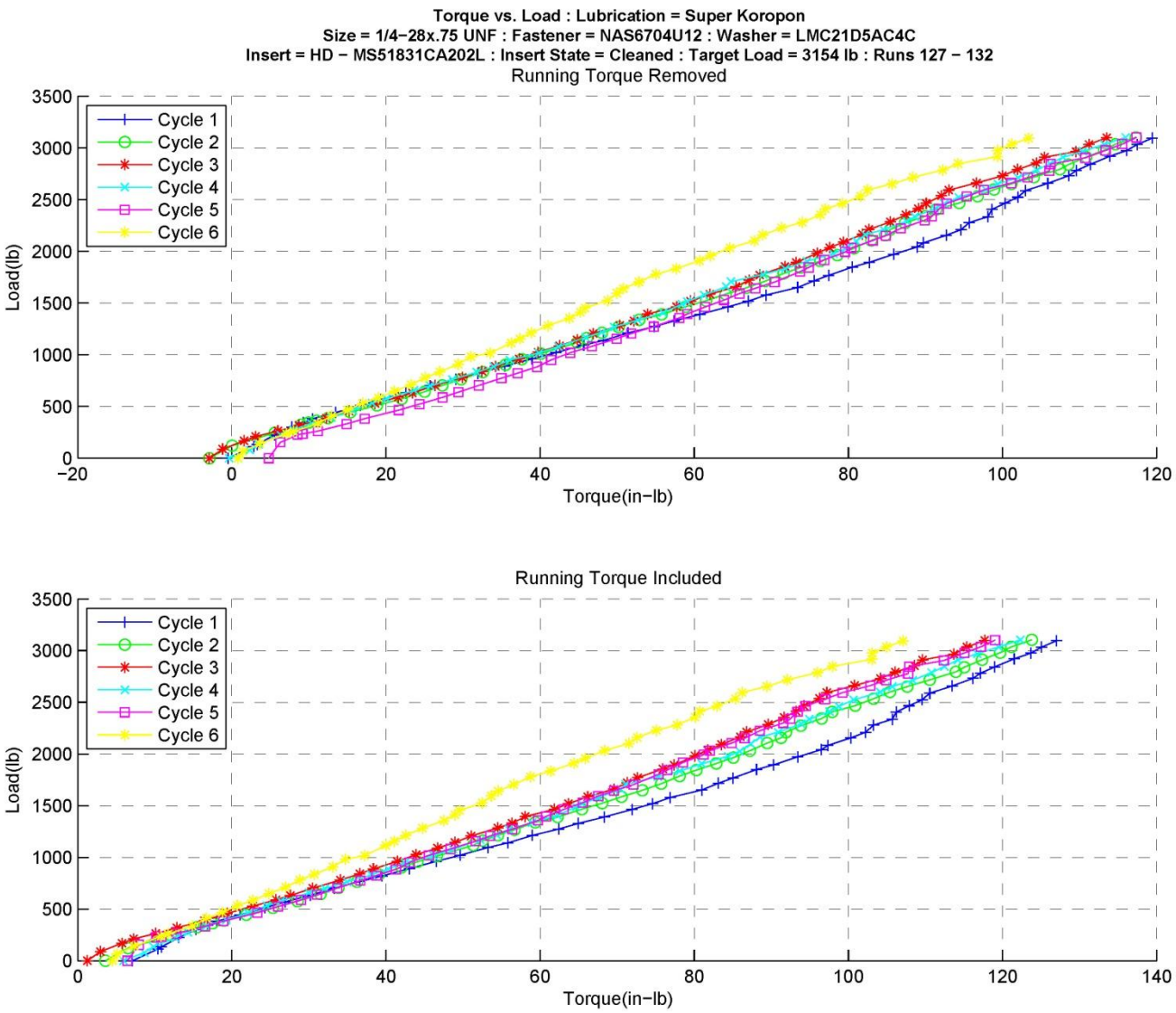

Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = ExHD − MS51832CA202L : Insert State = Uncleaned : Target Load = 3154 lb : Runs 97 − 102
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

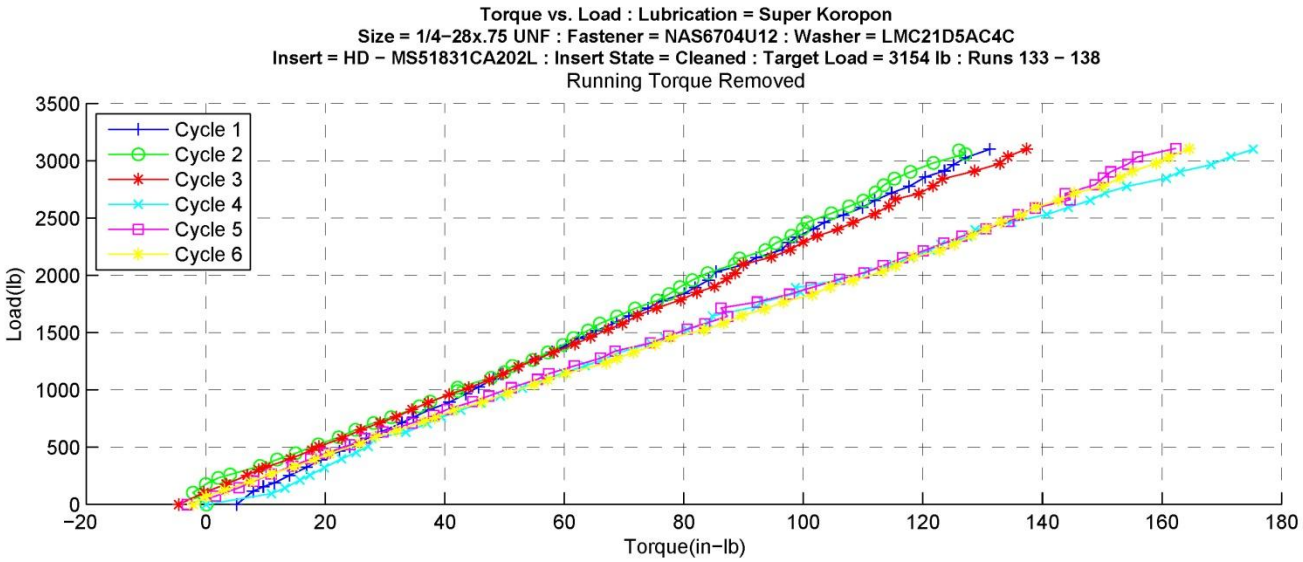

Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = ExHD − MS51832CA202L : Insert State = Cleaned : Target Load = 3154 lb : Runs 103 − 108
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

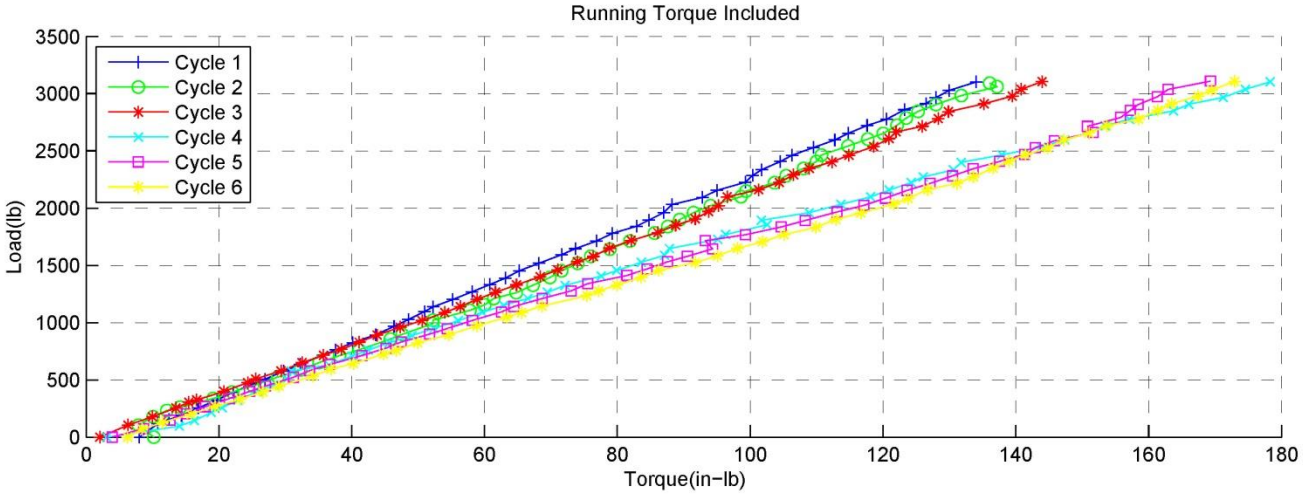

Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = ExHD − MS51832CA202L : Insert State = Cleaned : Target Load = 3154 lb : Runs 109 − 113
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Load(lb)
Torque(in−lb)

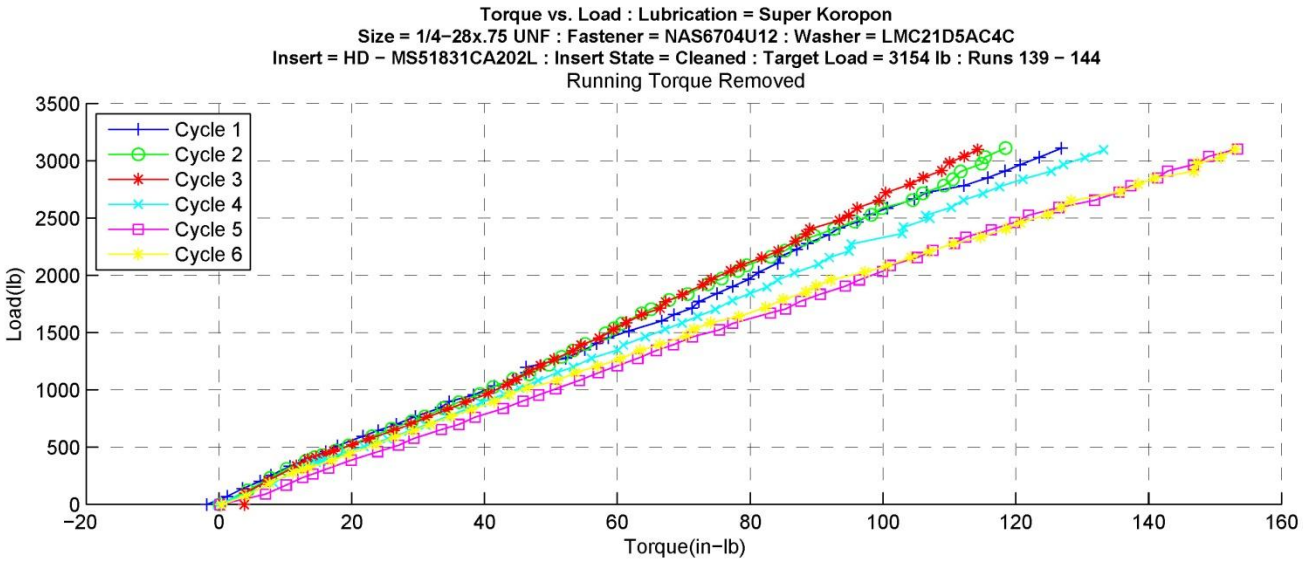

Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = ExHD − MS51832CA202L : Insert State = Cleaned : Target Load = 3154 lb : Runs 115 − 120
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

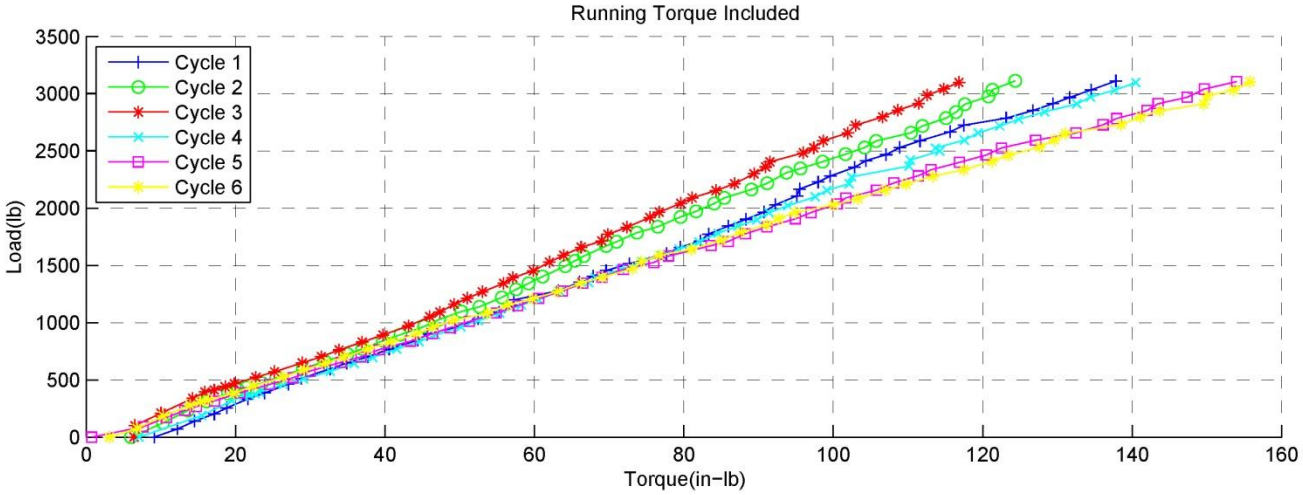

Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = ExHD − MS51832CA202L : Insert State = Cleaned : Target Load = 3154 lb : Runs 121 − 126
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

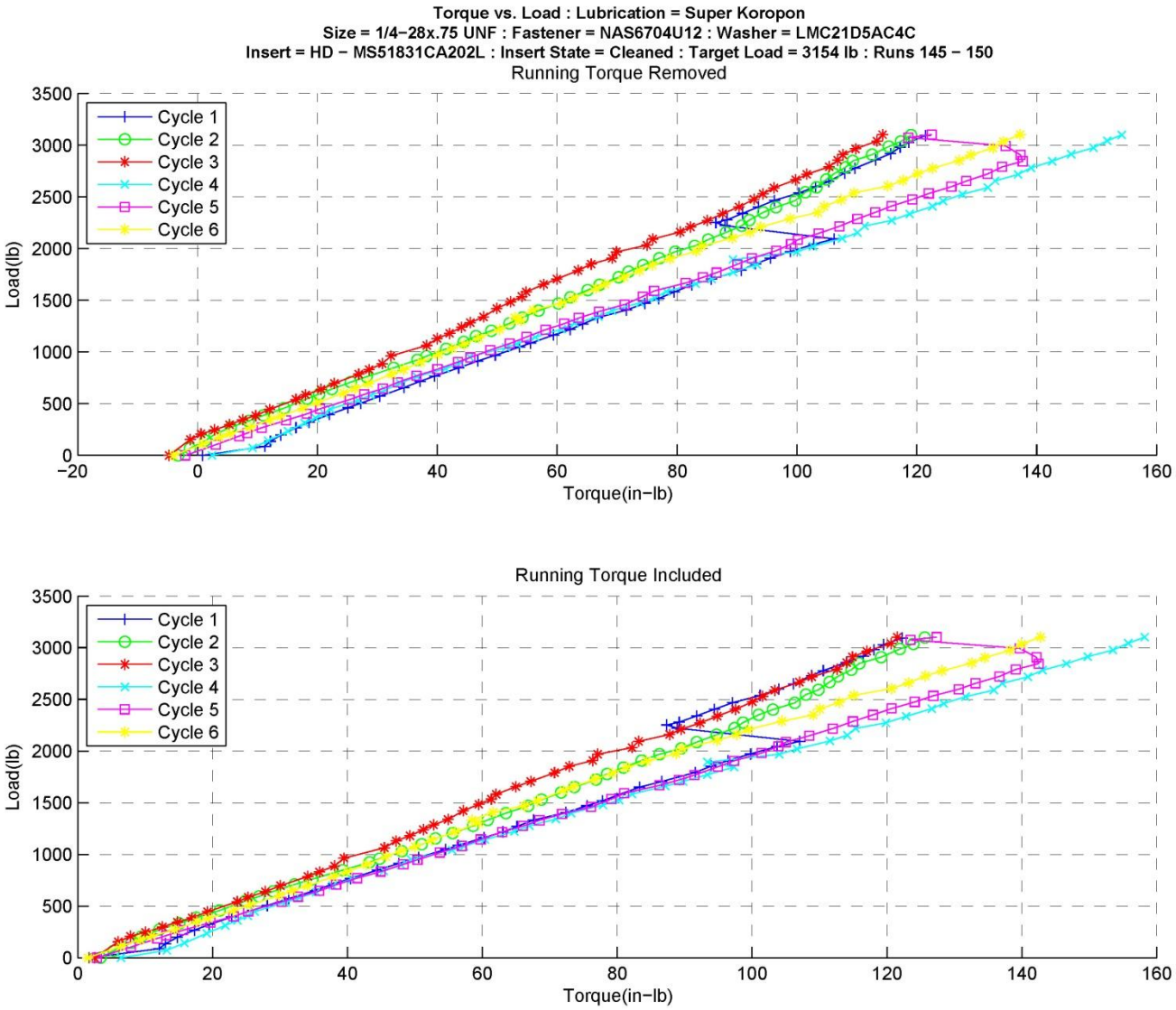

Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = HD − MS51831CA202L : Insert State = Cleaned : Target Load = 3154 lb : Runs 127 − 132
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

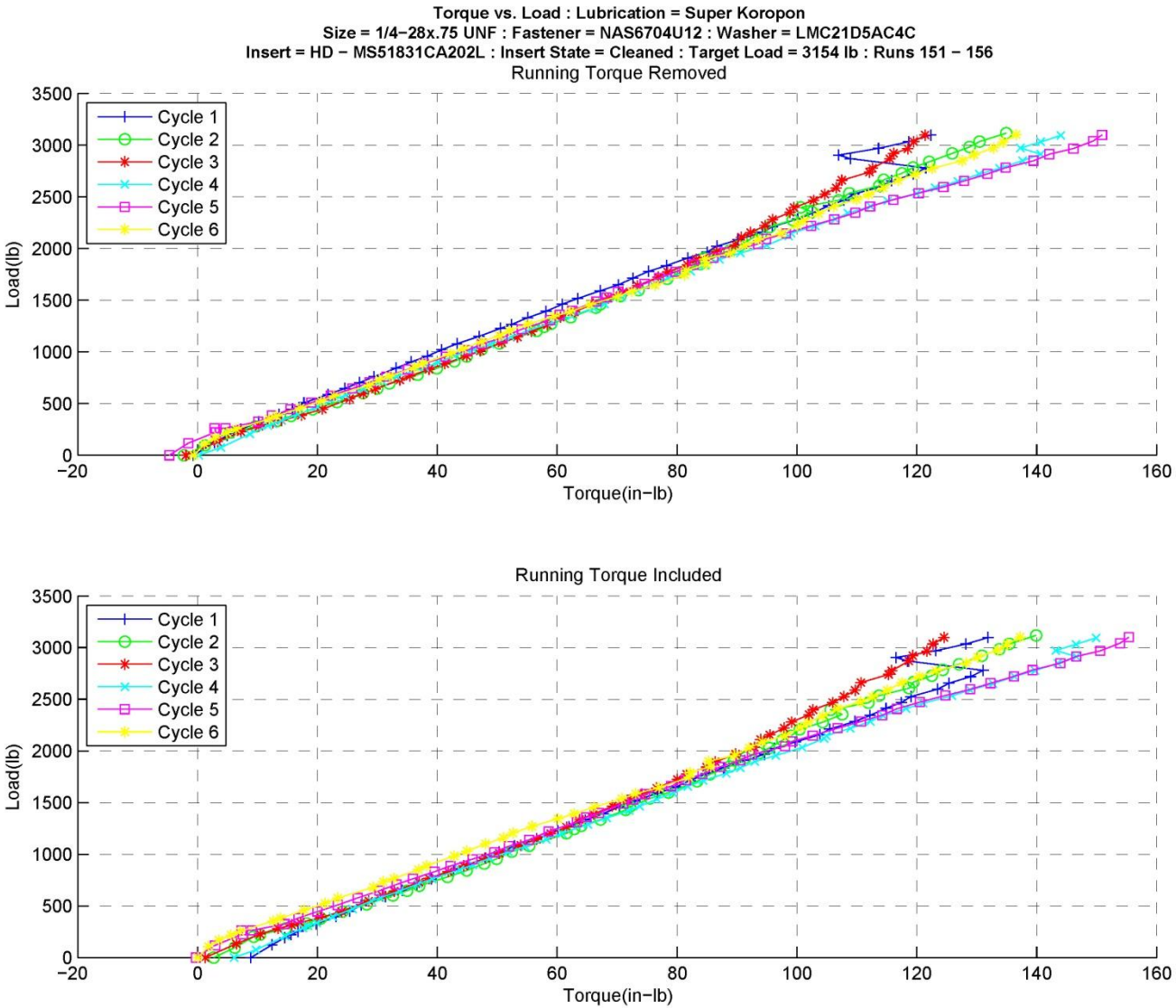

Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = HD − MS51831CA202L : Insert State = Cleaned : Target Load = 3154 lb : Runs 133 − 138
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
−20
0
20
40
60
80
100
120
140
160
180

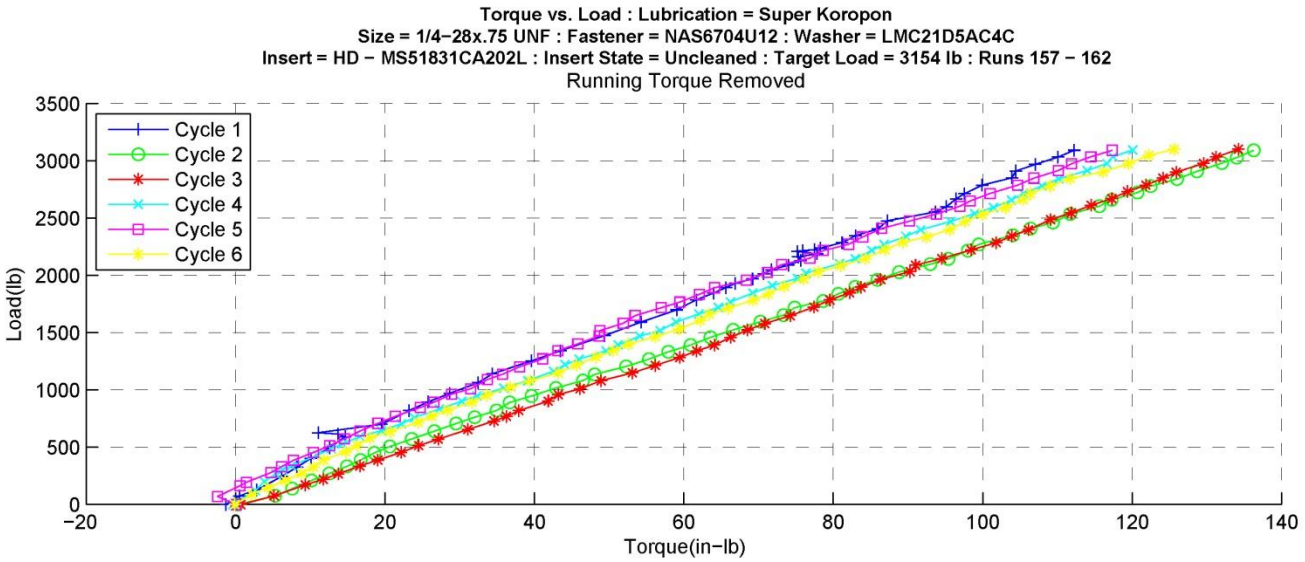

Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
120
140
160
180

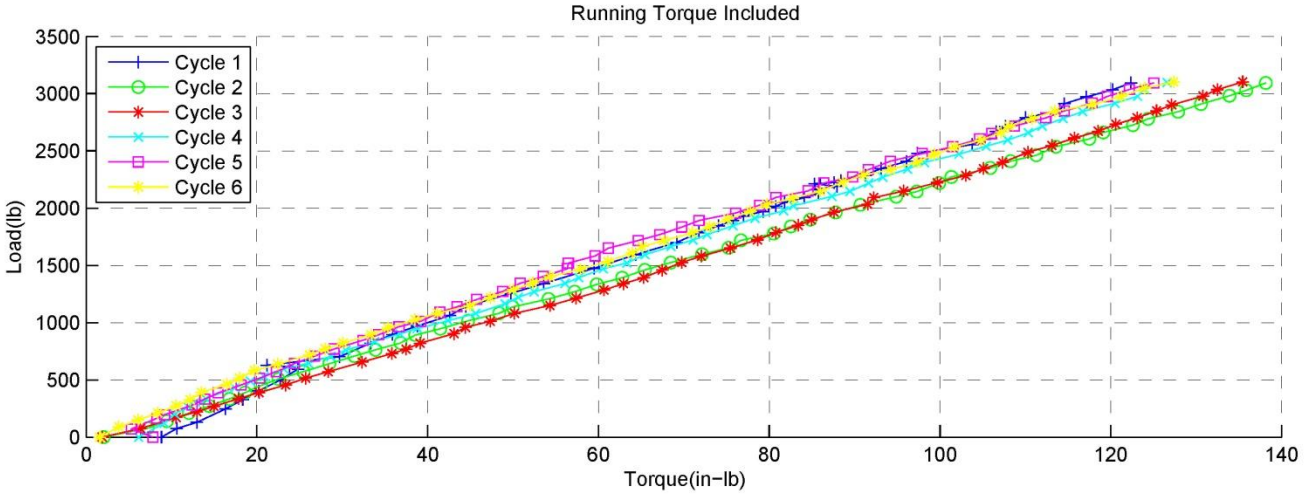

Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = HD − MS51831CA202L : Insert State = Cleaned : Target Load = 3154 lb : Runs 139 − 144
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

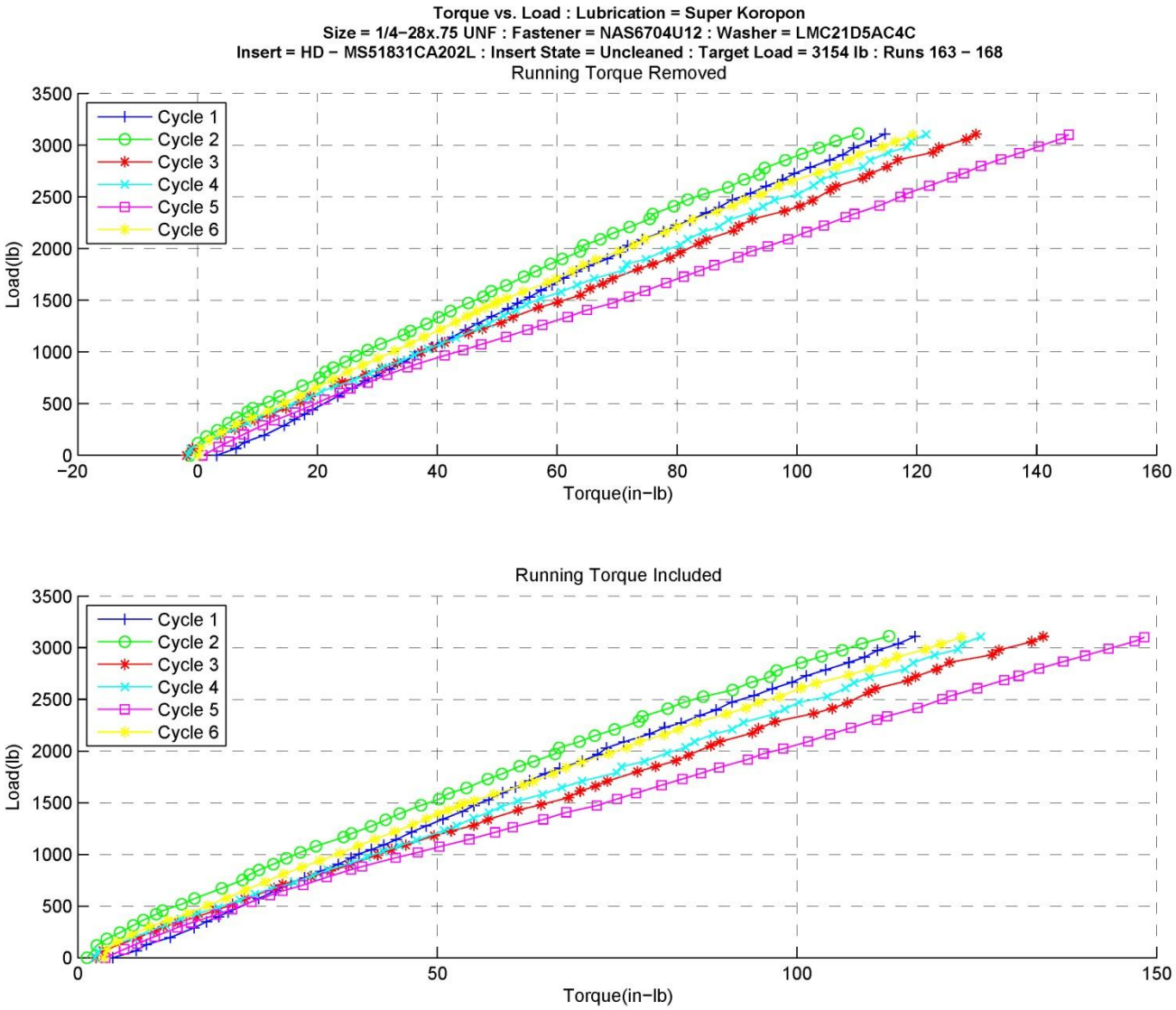

Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

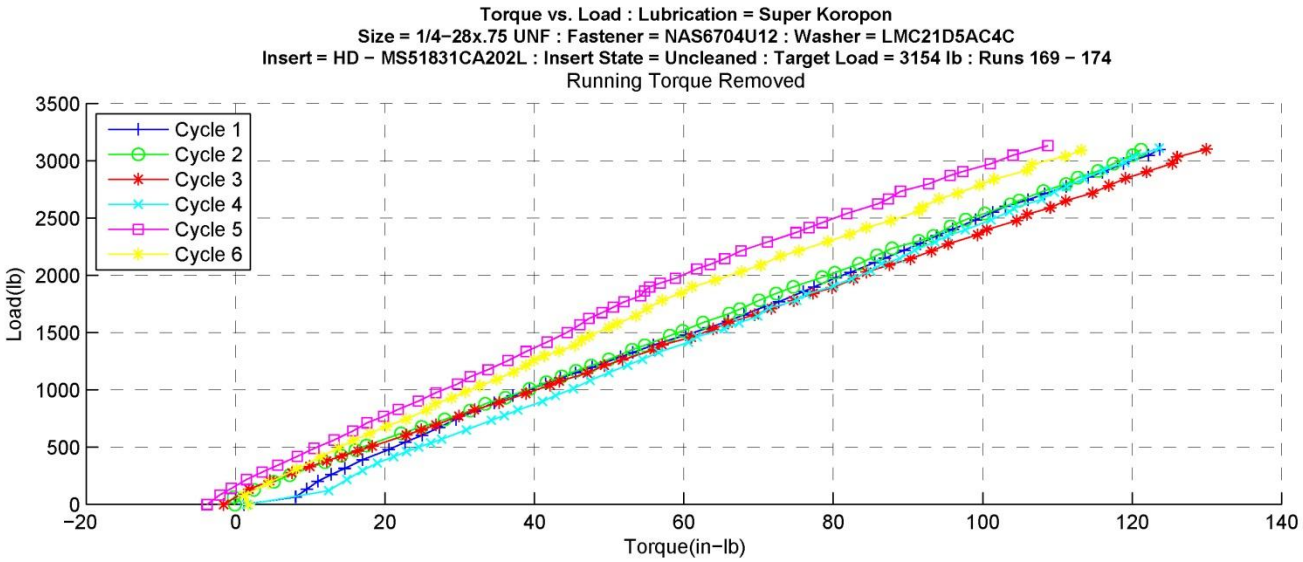

Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = HD − MS51831CA202L : Insert State = Cleaned : Target Load = 3154 lb : Runs 145 − 150
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

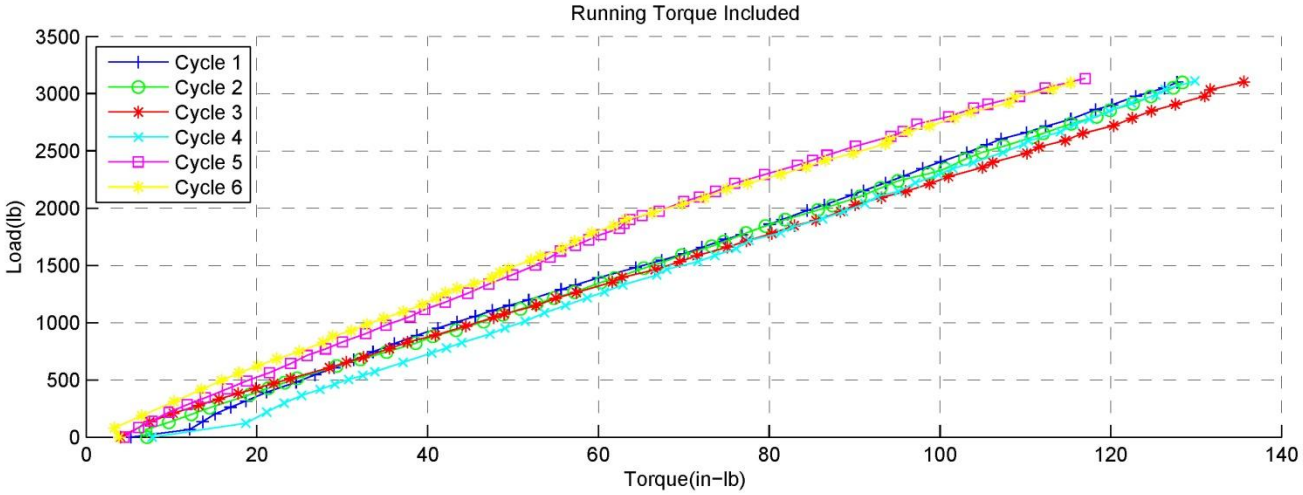

Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = HD − MS51831CA202L : Insert State = Cleaned : Target Load = 3154 lb : Runs 151 − 156
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

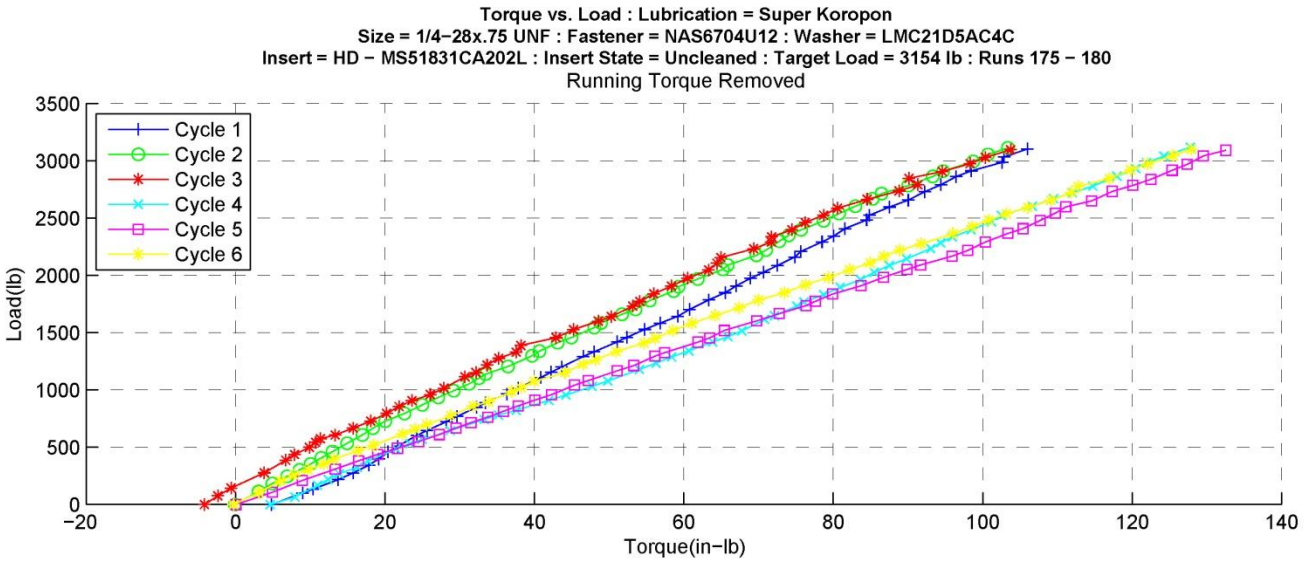

Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = HD − MS51831CA202L : Insert State = Uncleaned : Target Load = 3154 lb : Runs 157 − 162
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
−20
0
20
40
60
80
100
120
140

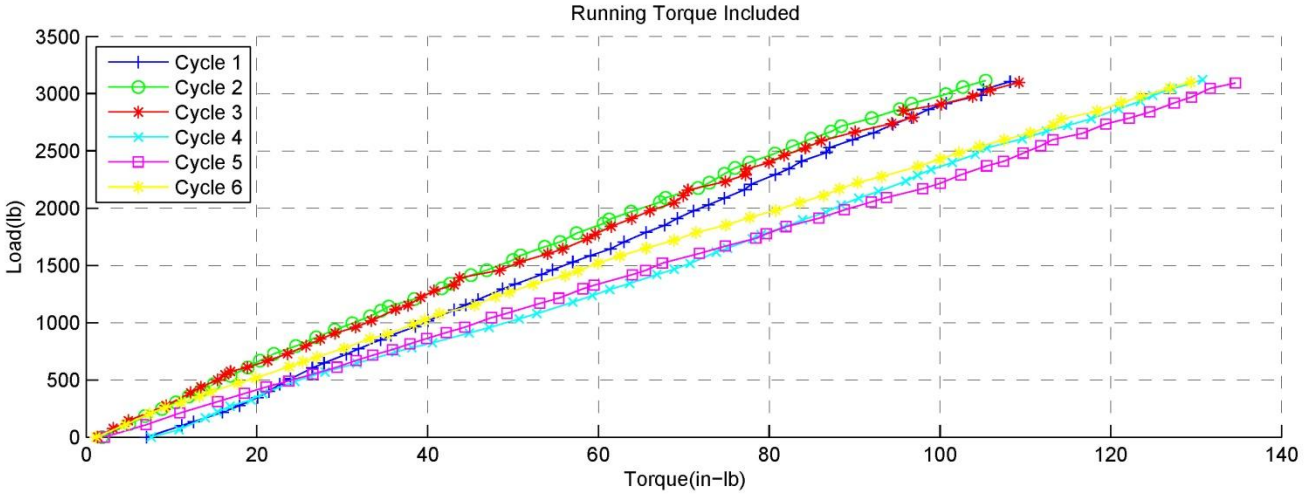

Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
120
140

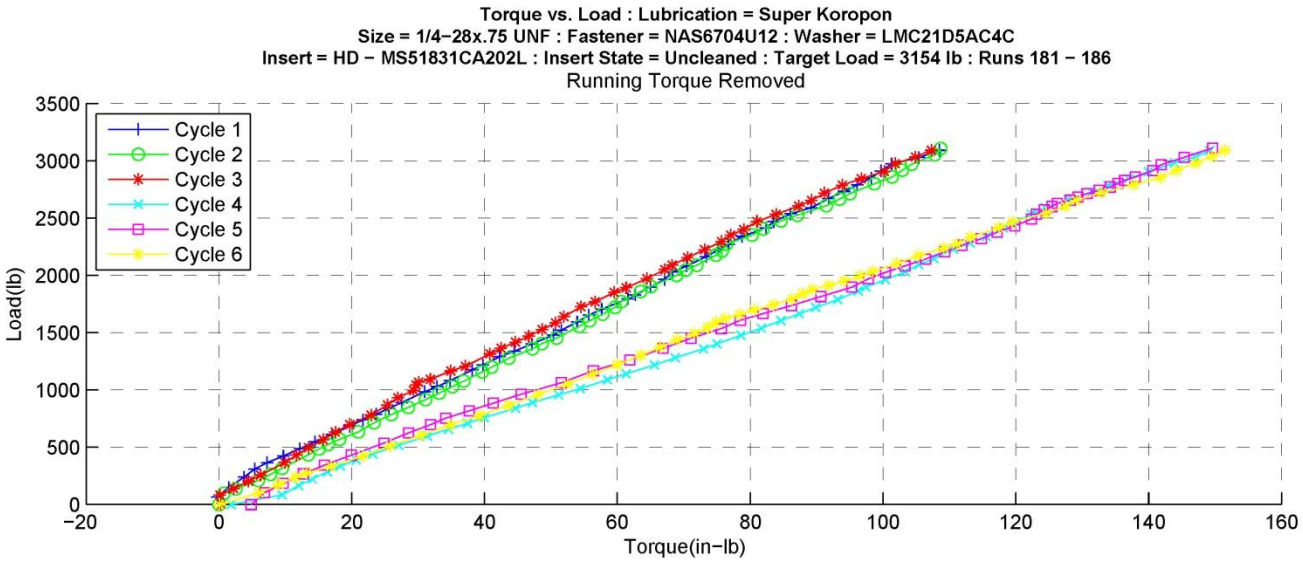

Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = HD − MS51831CA202L : Insert State = Uncleaned : Target Load = 3154 lb : Runs 163 − 168
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

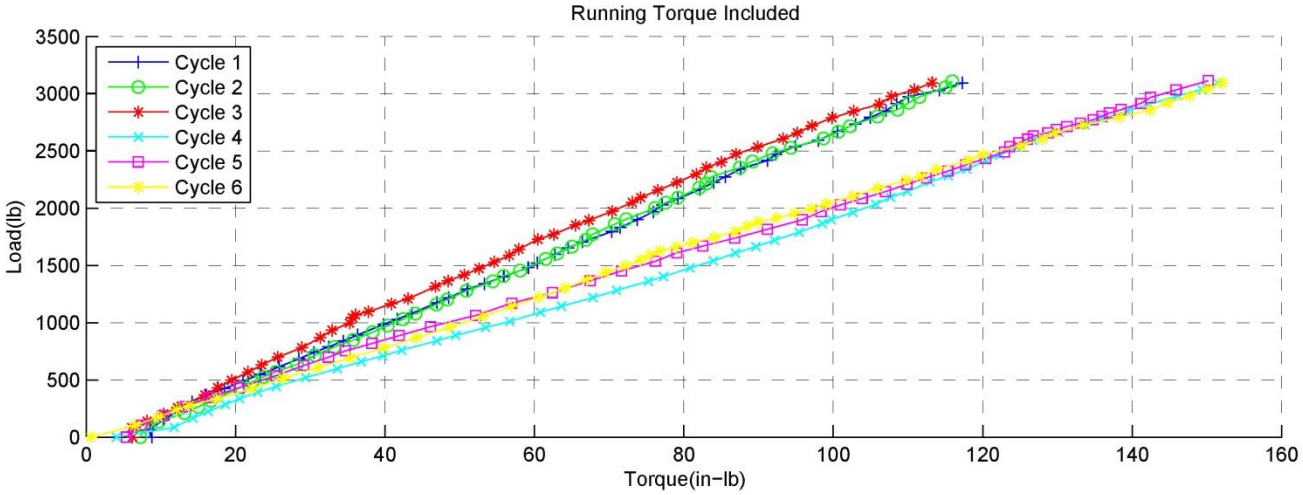

Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = HD − MS51831CA202L : Insert State = Uncleaned : Target Load = 3154 lb : Runs 169 − 174
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
−20
0
20
40
60
80
100
120
140


Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
120
140


Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = HD − MS51831CA202L : Insert State = Uncleaned : Target Load = 3154 lb : Runs 175 − 180
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

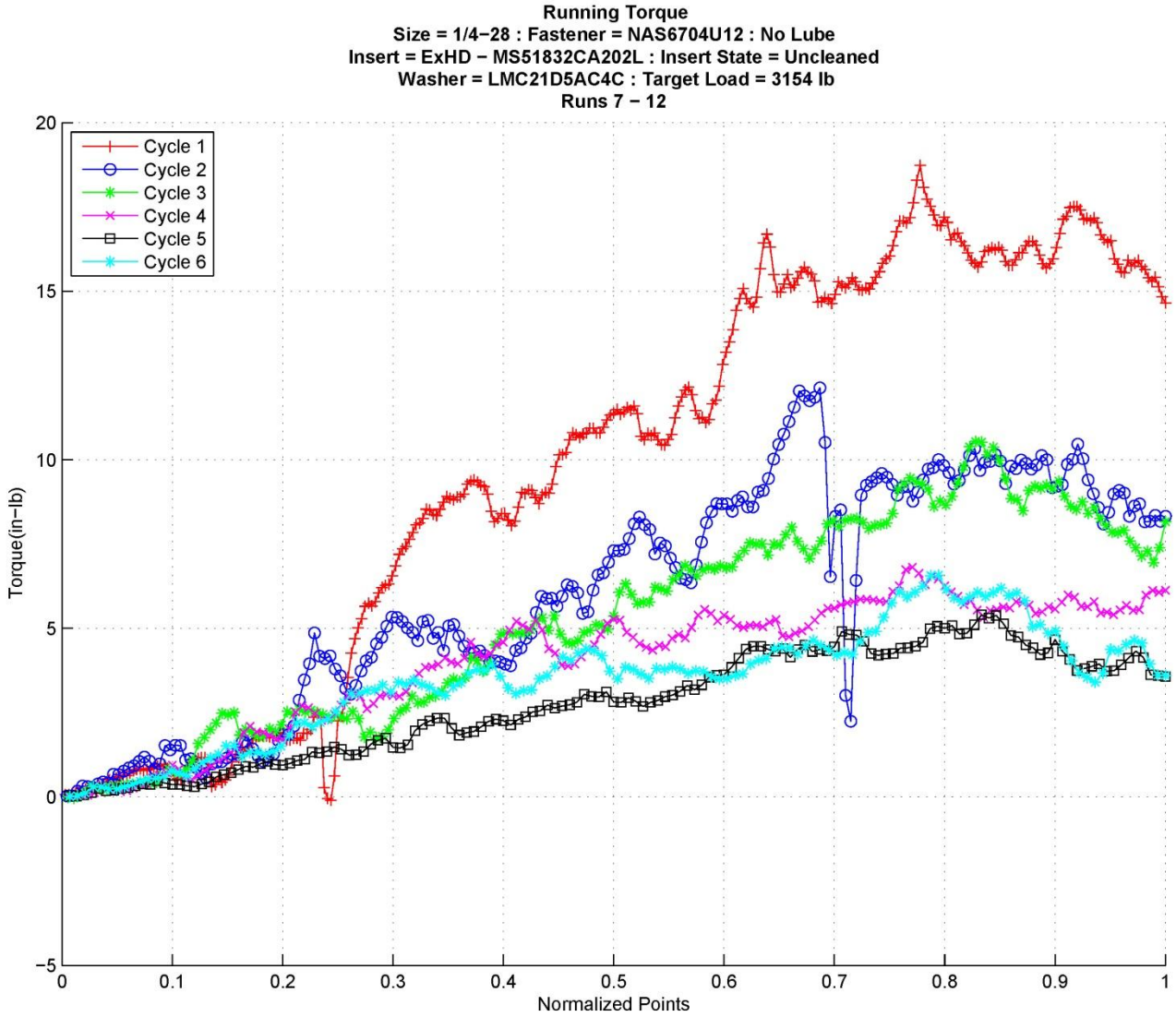

Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

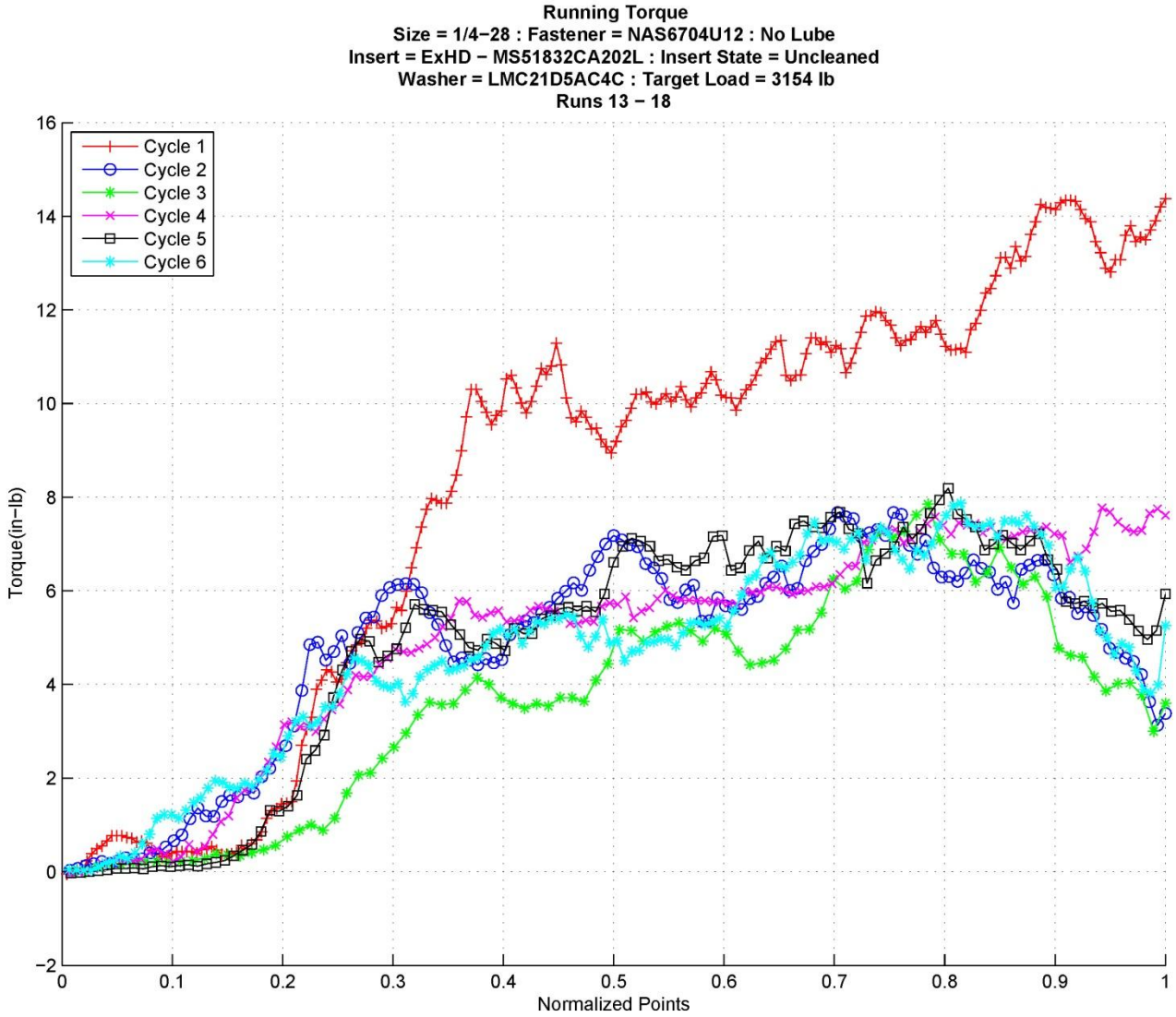

Torque vs. Load : Lubrication = Super Koropon
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Washer = LMC21D5AC4C
Insert = HD − MS51831CA202L : Insert State = Uncleaned : Target Load = 3154 lb : Runs 181 − 186
Running Torque Removed
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

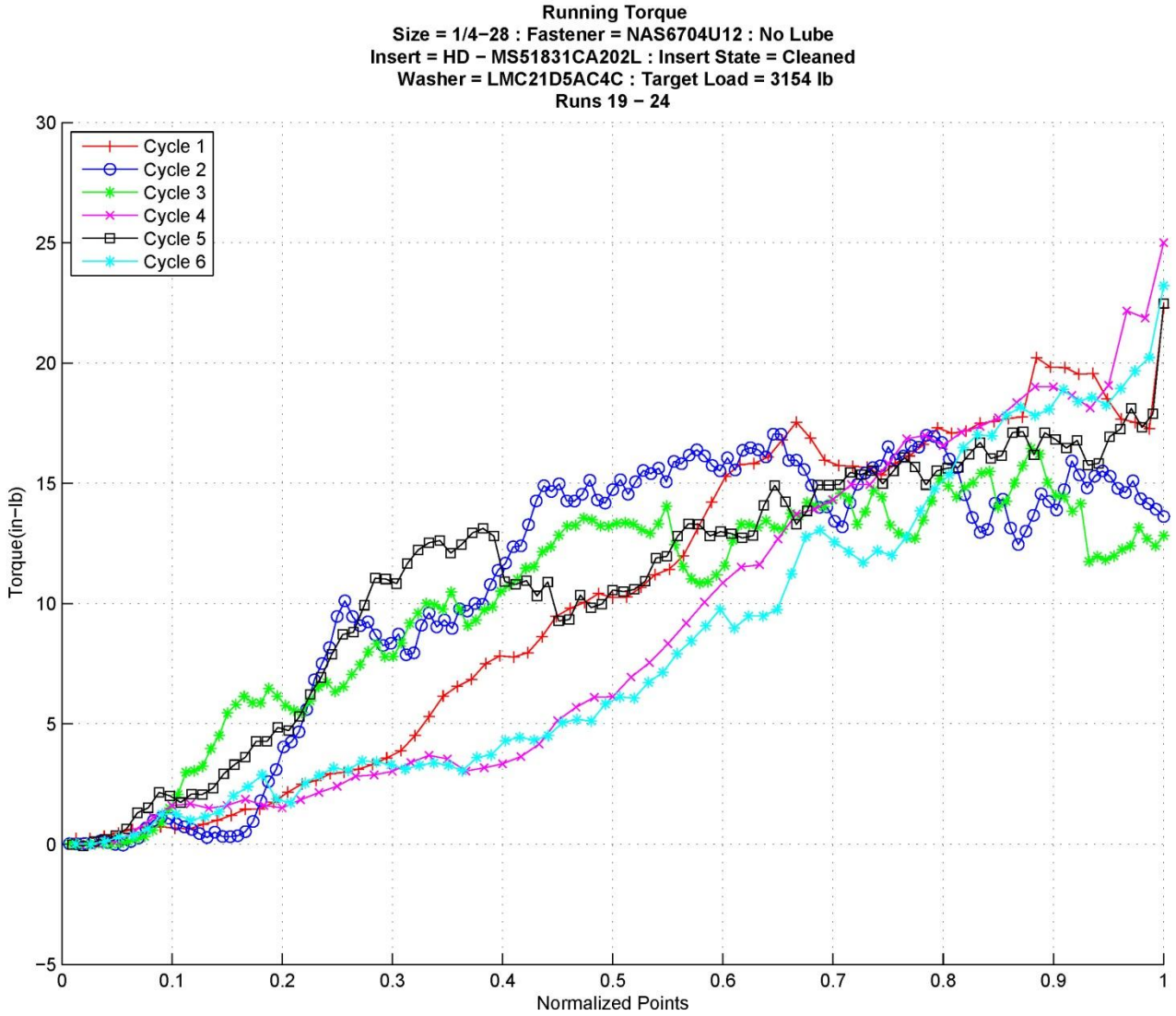

Running Torque Included
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Load(lb)
Torque(in−lb)

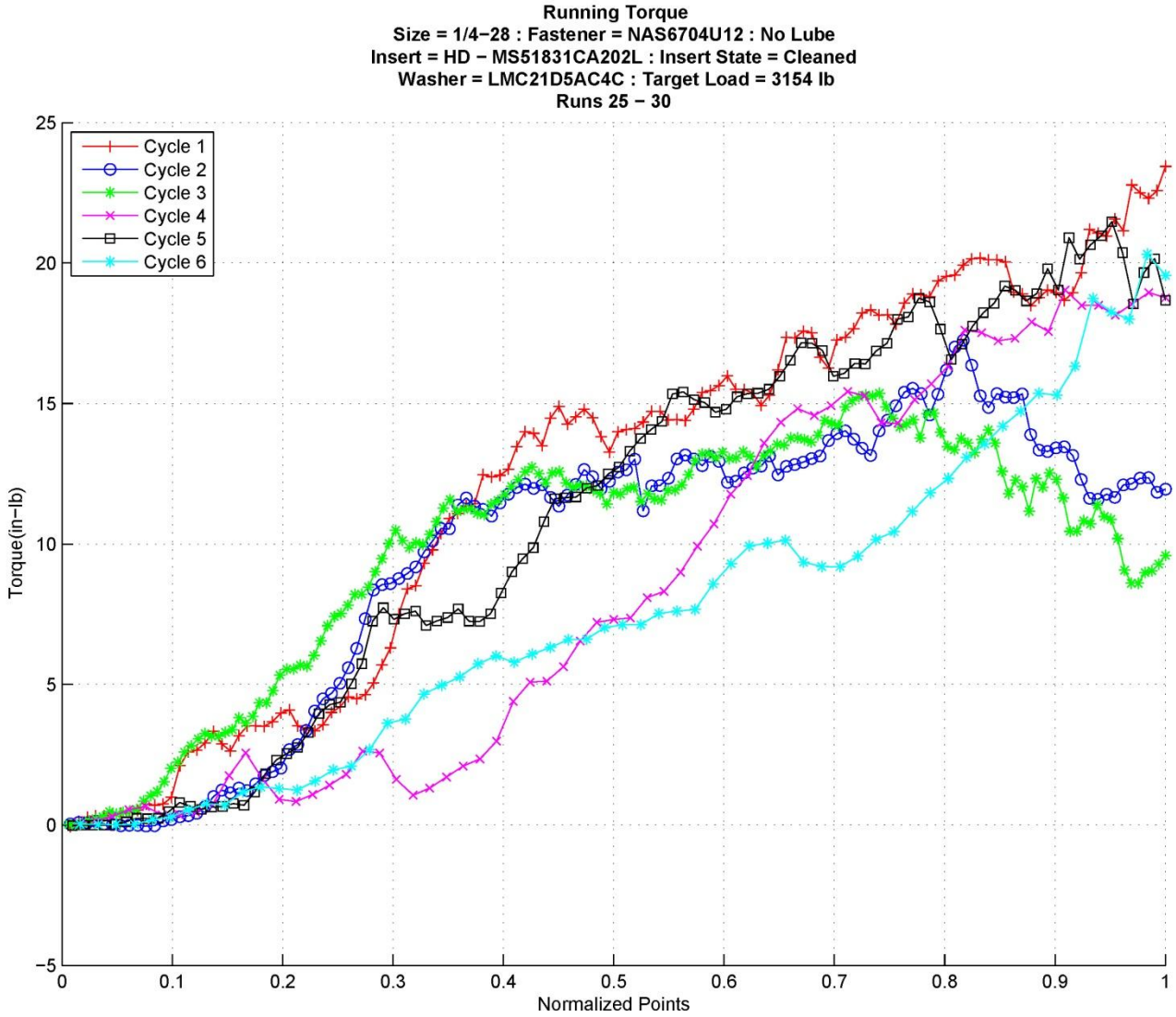
Appendix B:

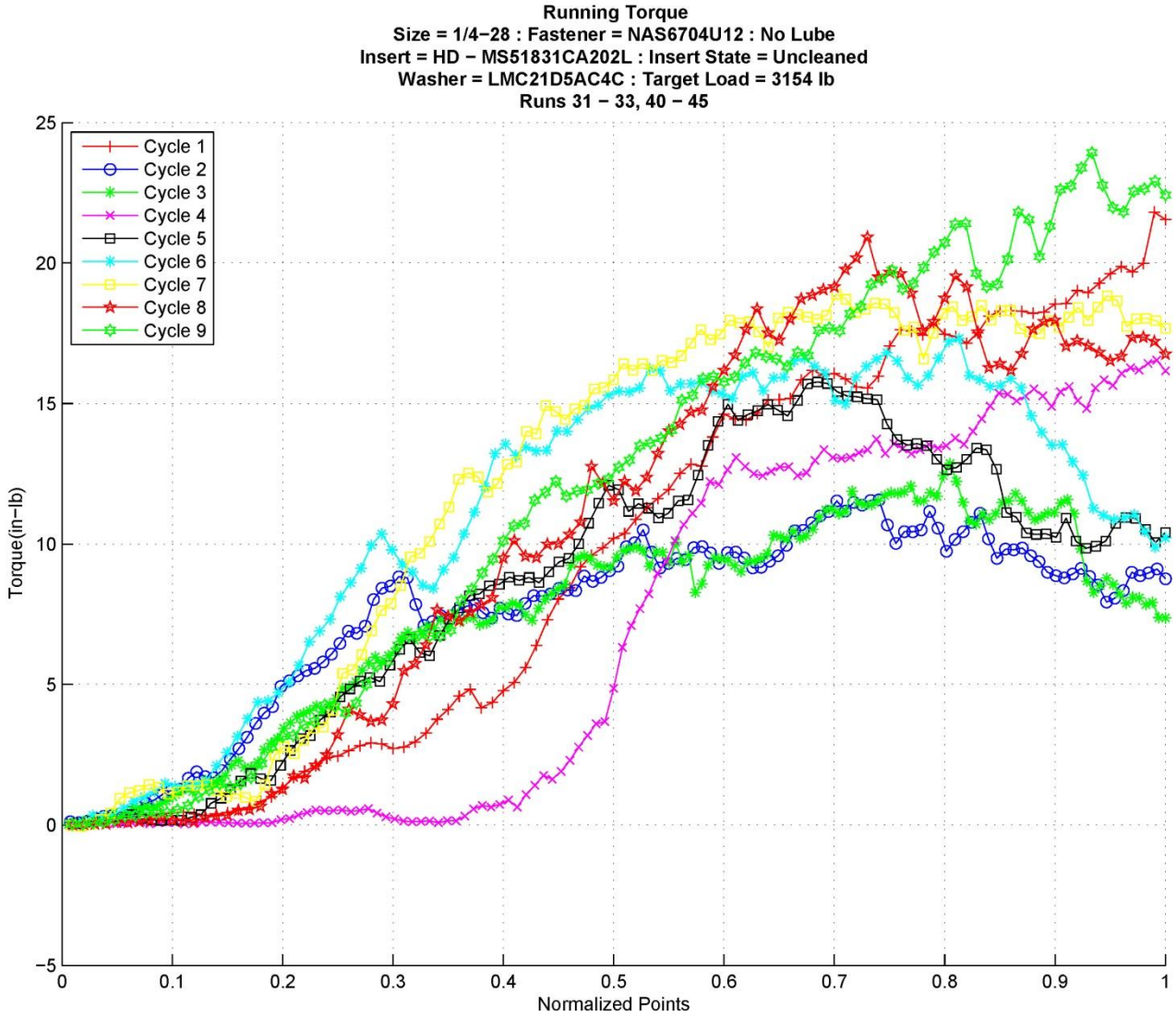
Section 1	¼-28 Dry Torque Tension Plots
Section 2	¼-28 Wet Torque Tension Plots
Section 3	¼-28 Dry Running Torque Plots
Section 4	¼-28 Wet Running Torque Plots
Section 5	¼-28 Dry Cycle Plots: Torque vs. Load
Section 6	¼-28 Wet Cycle Plots: Torque vs. Load
Section 7	¼-28 Friction Coefficients
Section 8	¼-28 Test Plate Layouts
Section 9	¼-28 Dry Run Logs
Section 10	¼-28 Wet Run Logs

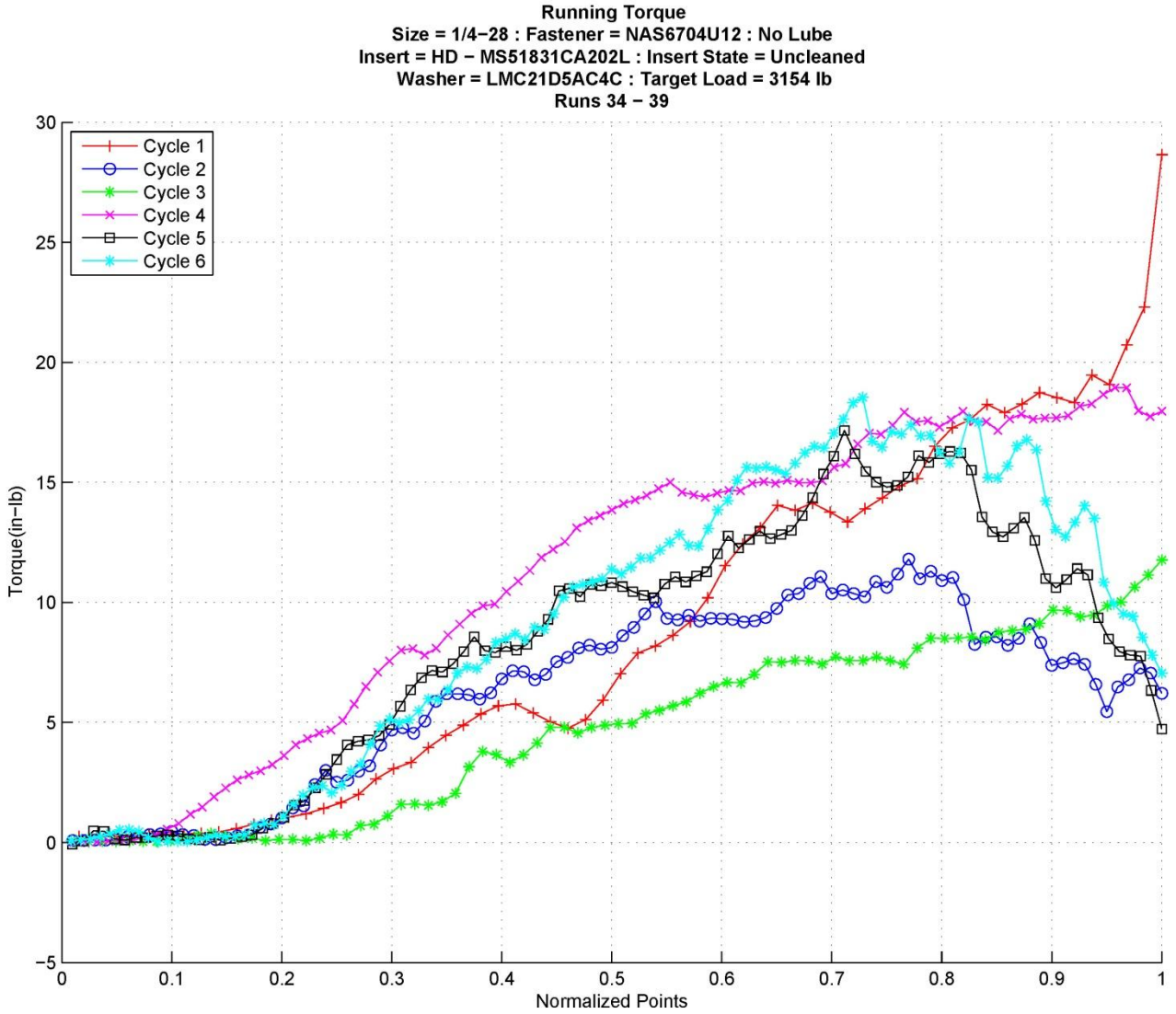

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : No Lube
Insert = ExHD − MS51832CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 7 − 12
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
20
15
10
5
0
−5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : No Lube
Insert = ExHD − MS51832CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 13 − 18
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
16
14
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : No Lube
Insert = HD − MS51831CA202L : Insert State = Cleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 19 − 24
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
30
25
20
15
10
5
0
−5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

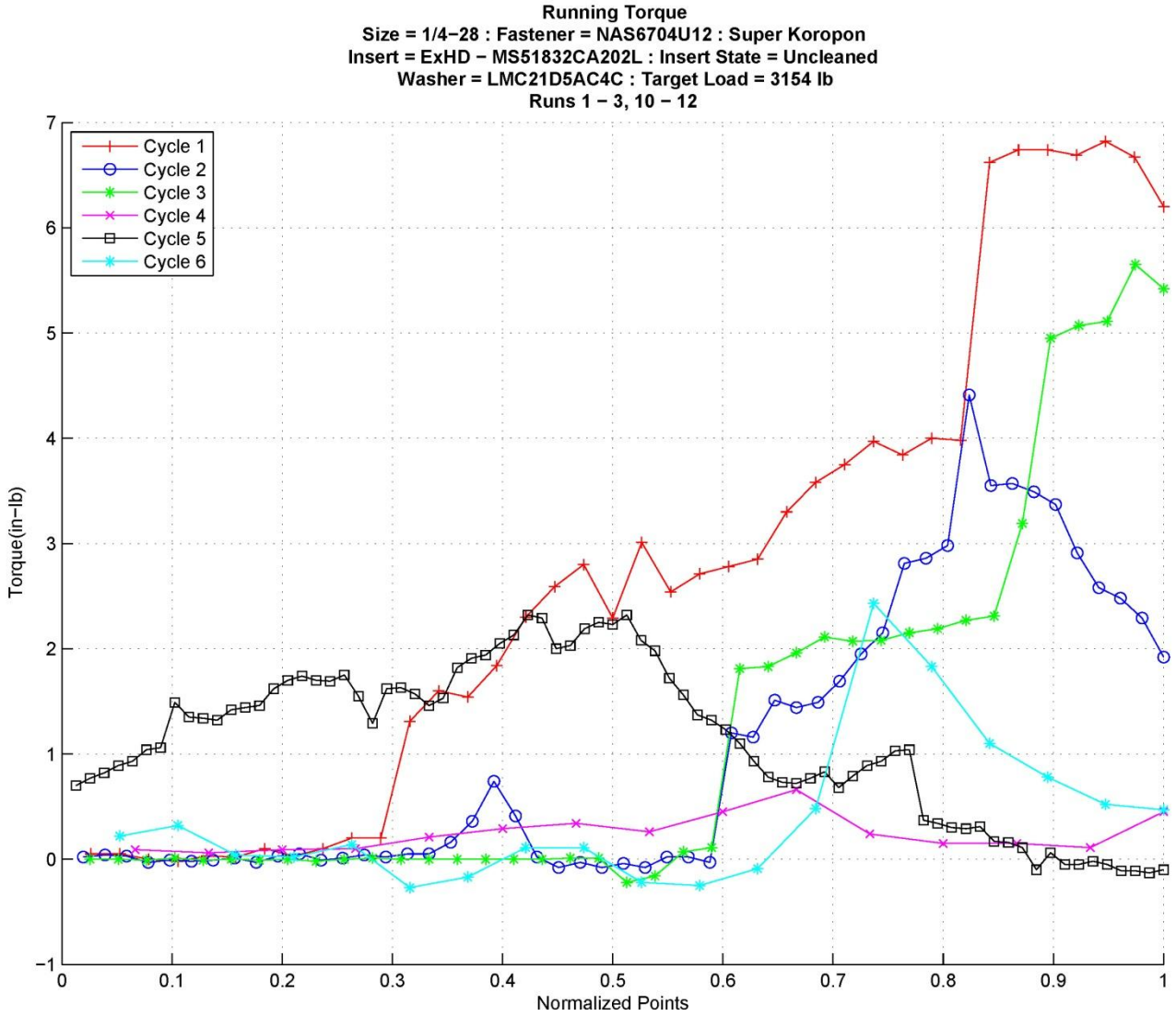

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : No Lube
Insert = HD − MS51831CA202L : Insert State = Cleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 25 − 30
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
25
20
15
10
5
0
−5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

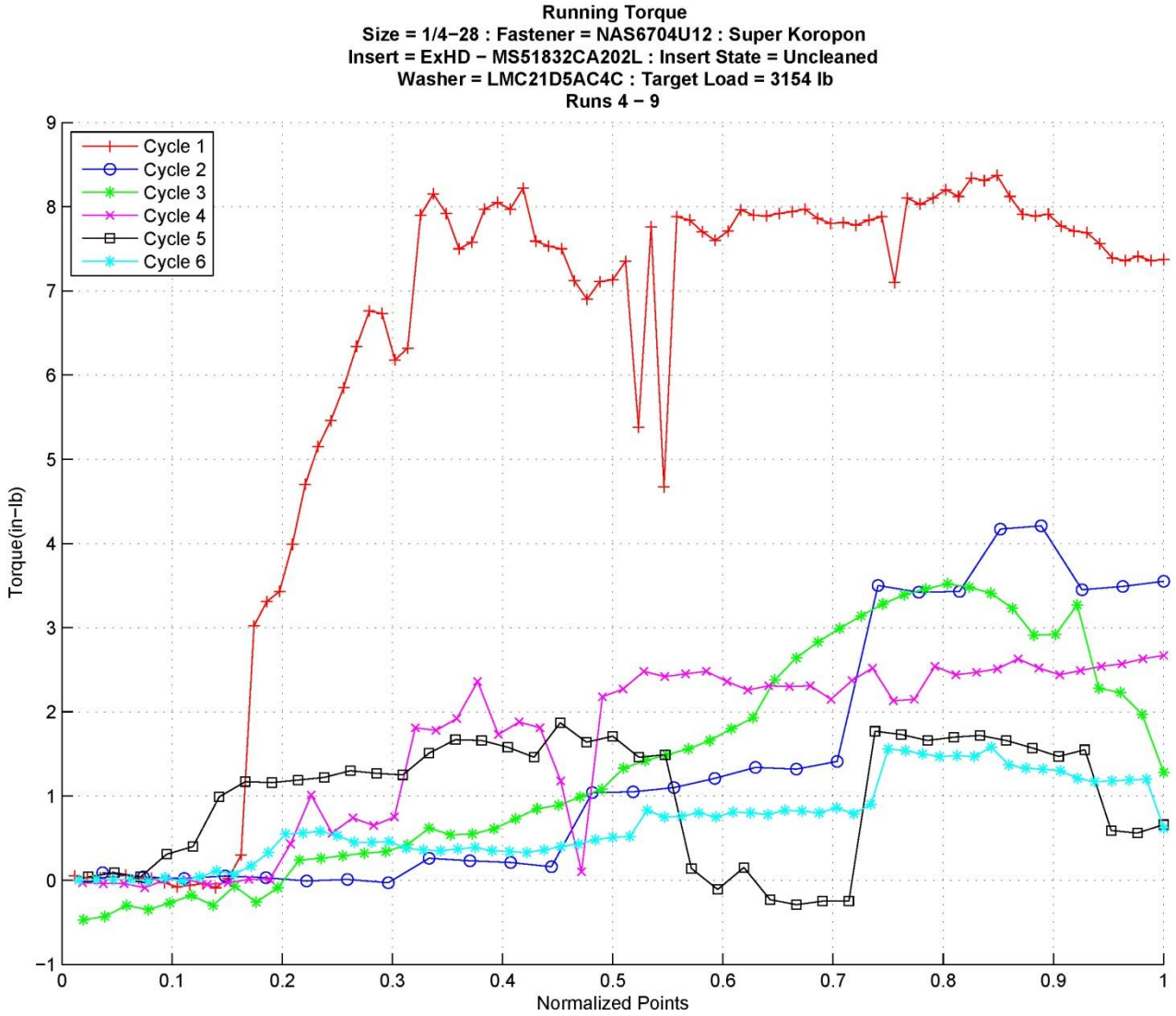

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : No Lube
Insert = HD − MS51831CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 31 − 33, 40 − 45
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Cycle 7
Cycle 8
Cycle 9
Torque(in−lb)
Normalized Points
25
20
15
10
5
0
−5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

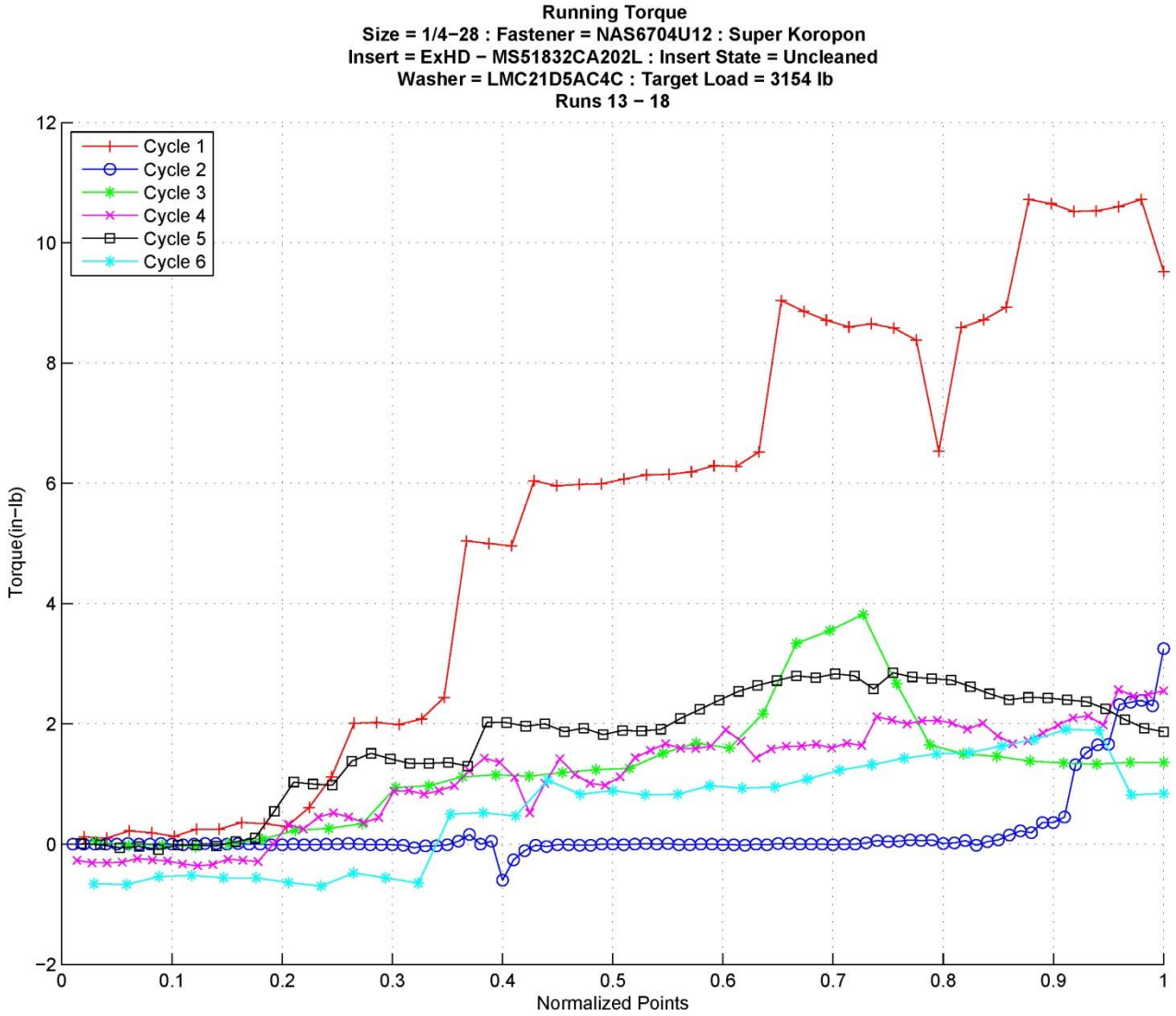

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : No Lube
Insert = HD − MS51831CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 34 − 39
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
30
25
20
15
10
5
0
−5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

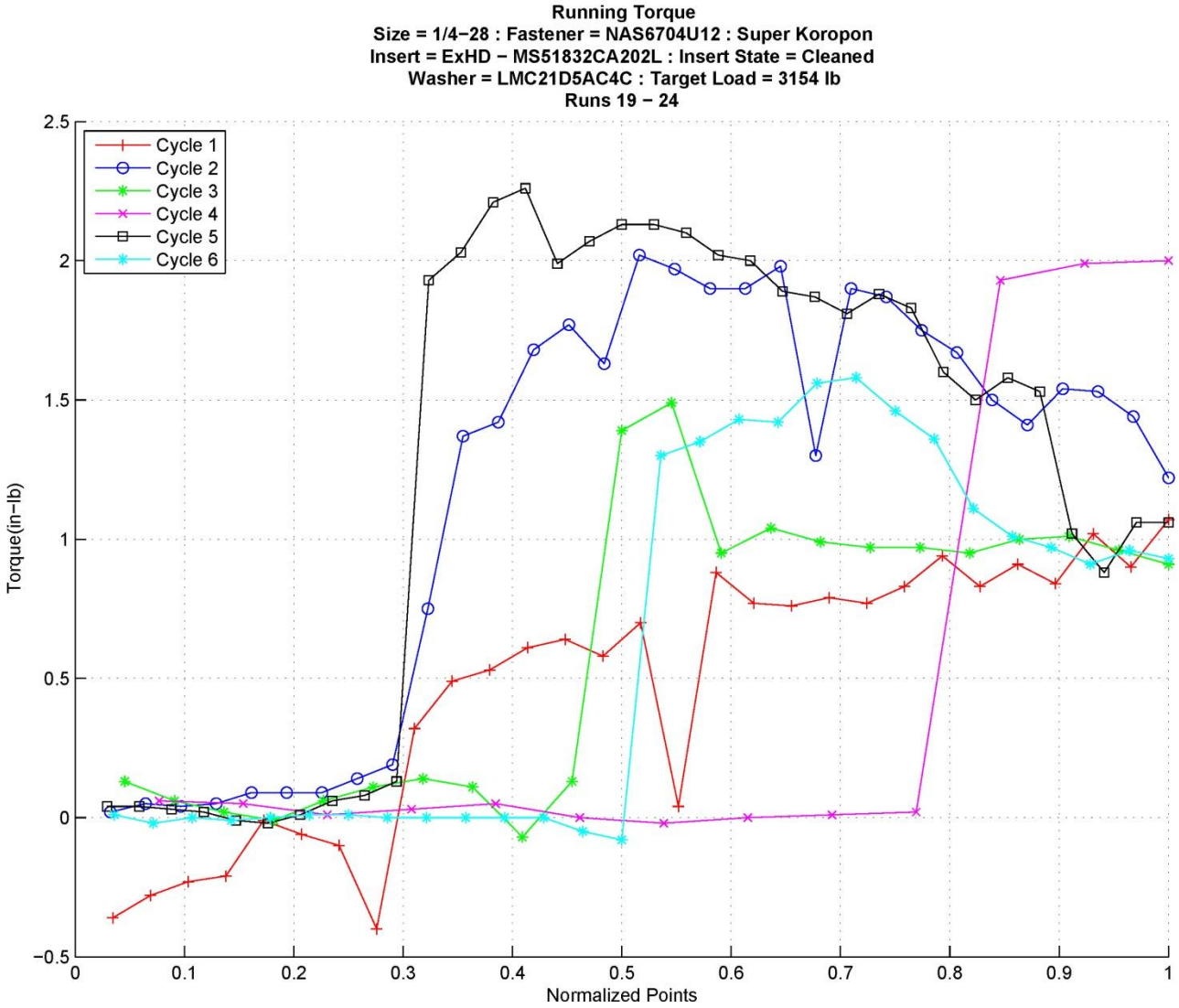
Appendix B:

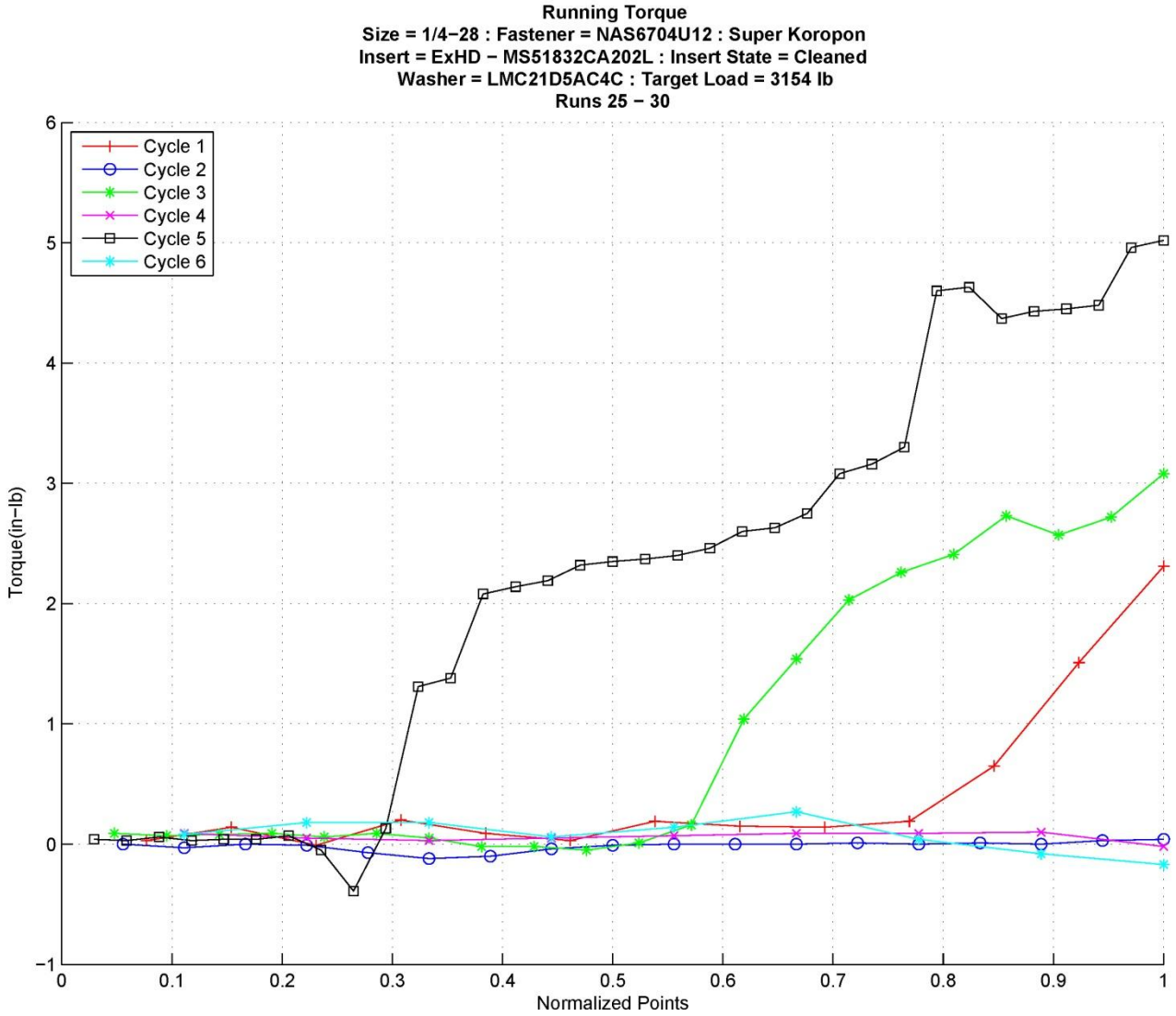
Section 1	¼-28 Dry Torque Tension Plots
Section 2	¼-28 Wet Torque Tension Plots
Section 3	¼-28 Dry Running Torque Plots
Section 4	¼-28 Wet Running Torque Plots
Section 5	¼-28 Dry Cycle Plots: Torque vs. Load
Section 6	¼-28 Wet Cycle Plots: Torque vs. Load
Section 7	¼-28 Friction Coefficients
Section 8	¼-28 Test Plate Layouts
Section 9	¼-28 Dry Run Logs
Section 10	¼-28 Wet Run Logs

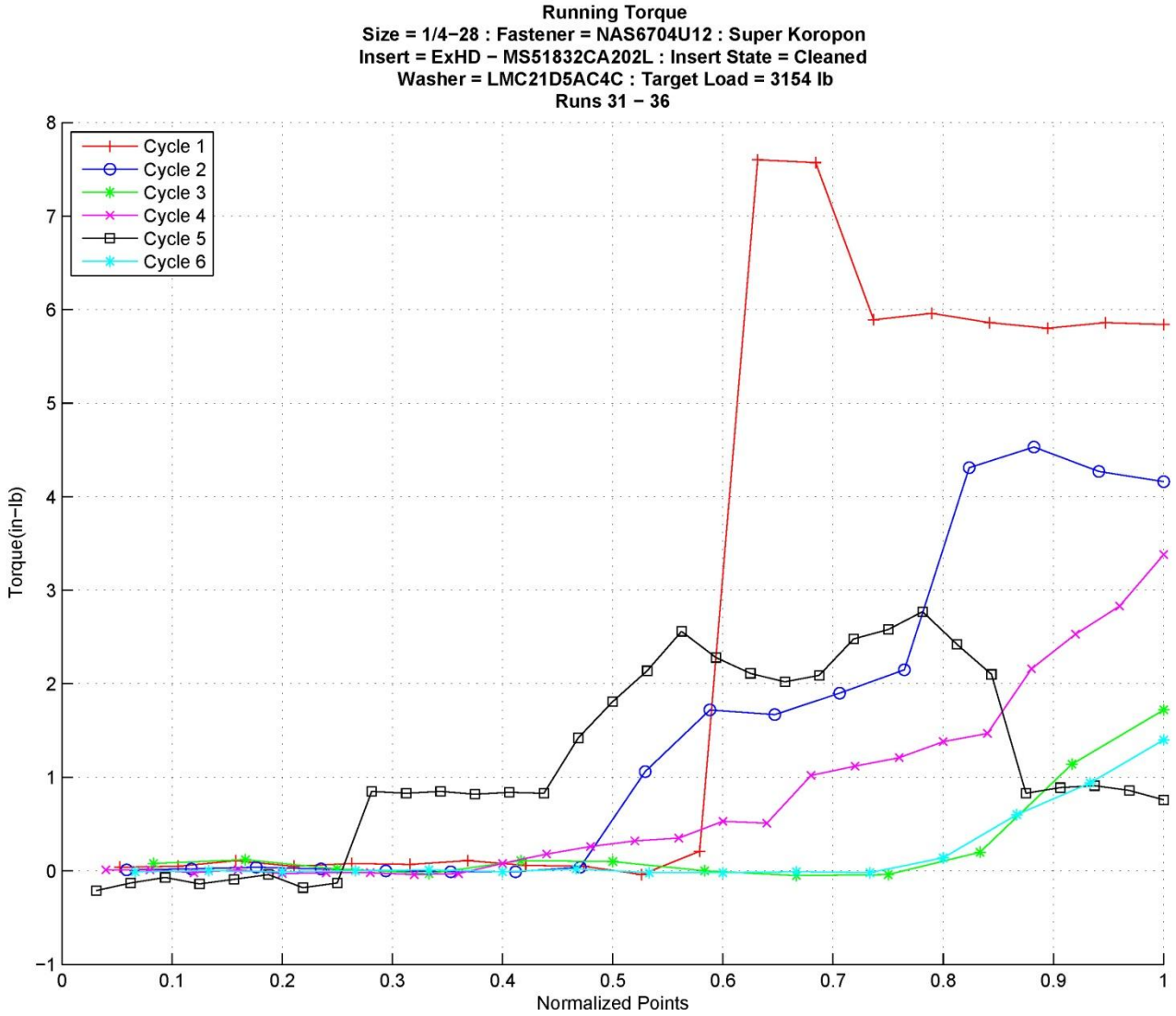

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = ExHD − MS51832CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 1 − 3, 10 − 12
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
7
6
5
4
3
2
1
0
−1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

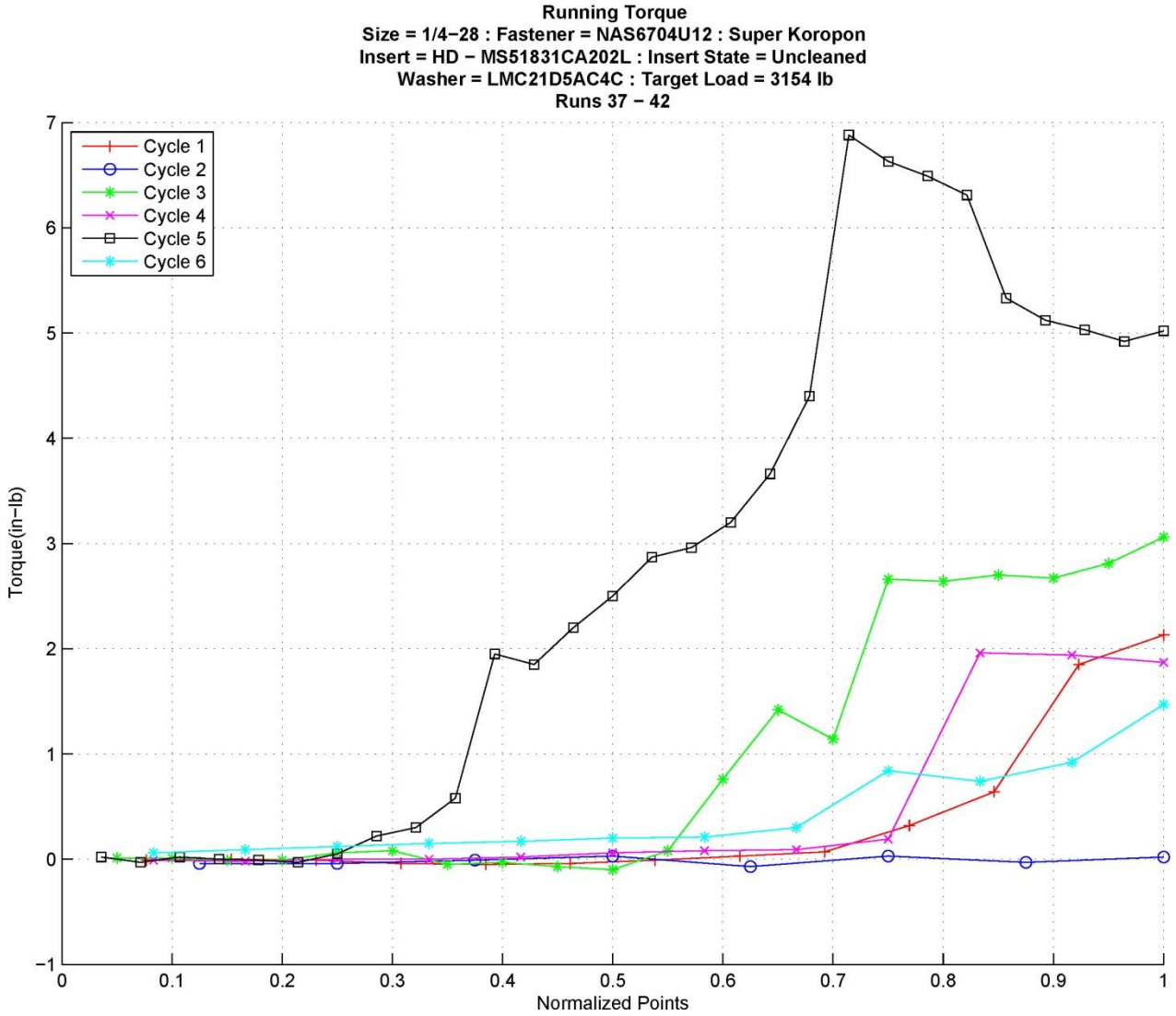

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = ExHD − MS51832CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 4 − 9
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
9
8
7
6
5
4
3
2
1
0
−1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

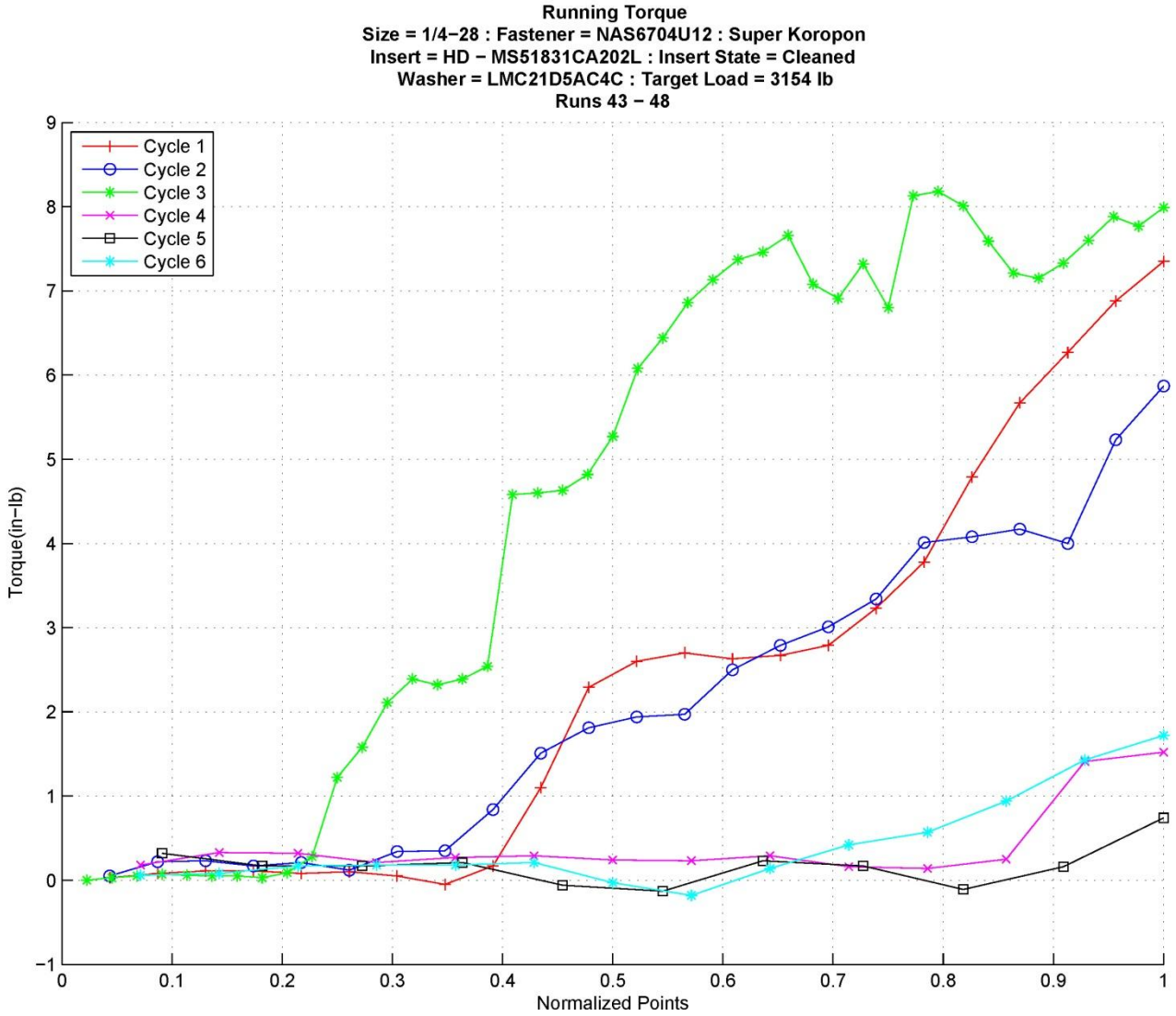

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = ExHD − MS51832CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 13 − 18
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

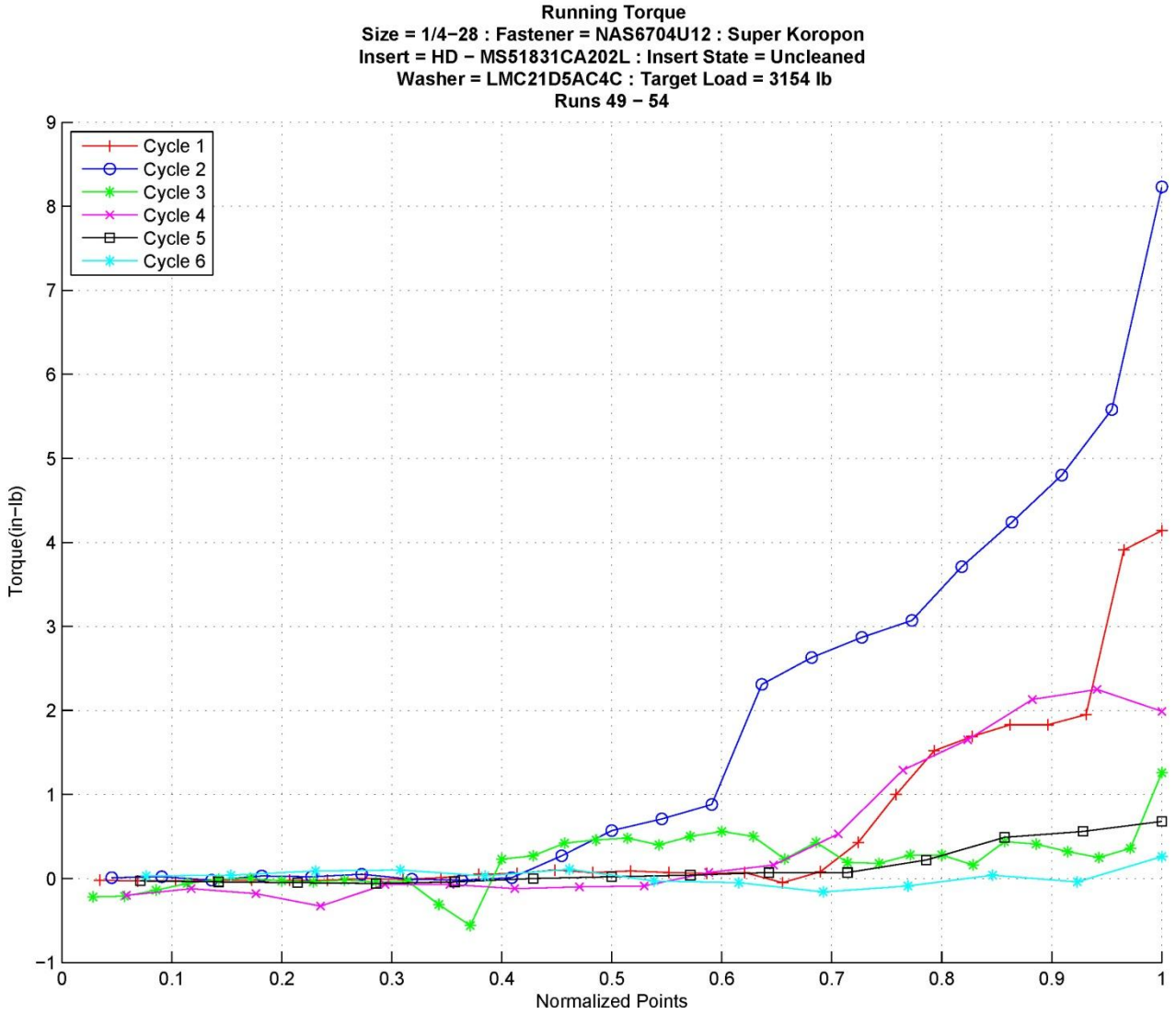

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = ExHD − MS51832CA202L : Insert State = Cleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 19 − 24
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
2.5
2
1.5
1
0.5
0
−0.5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

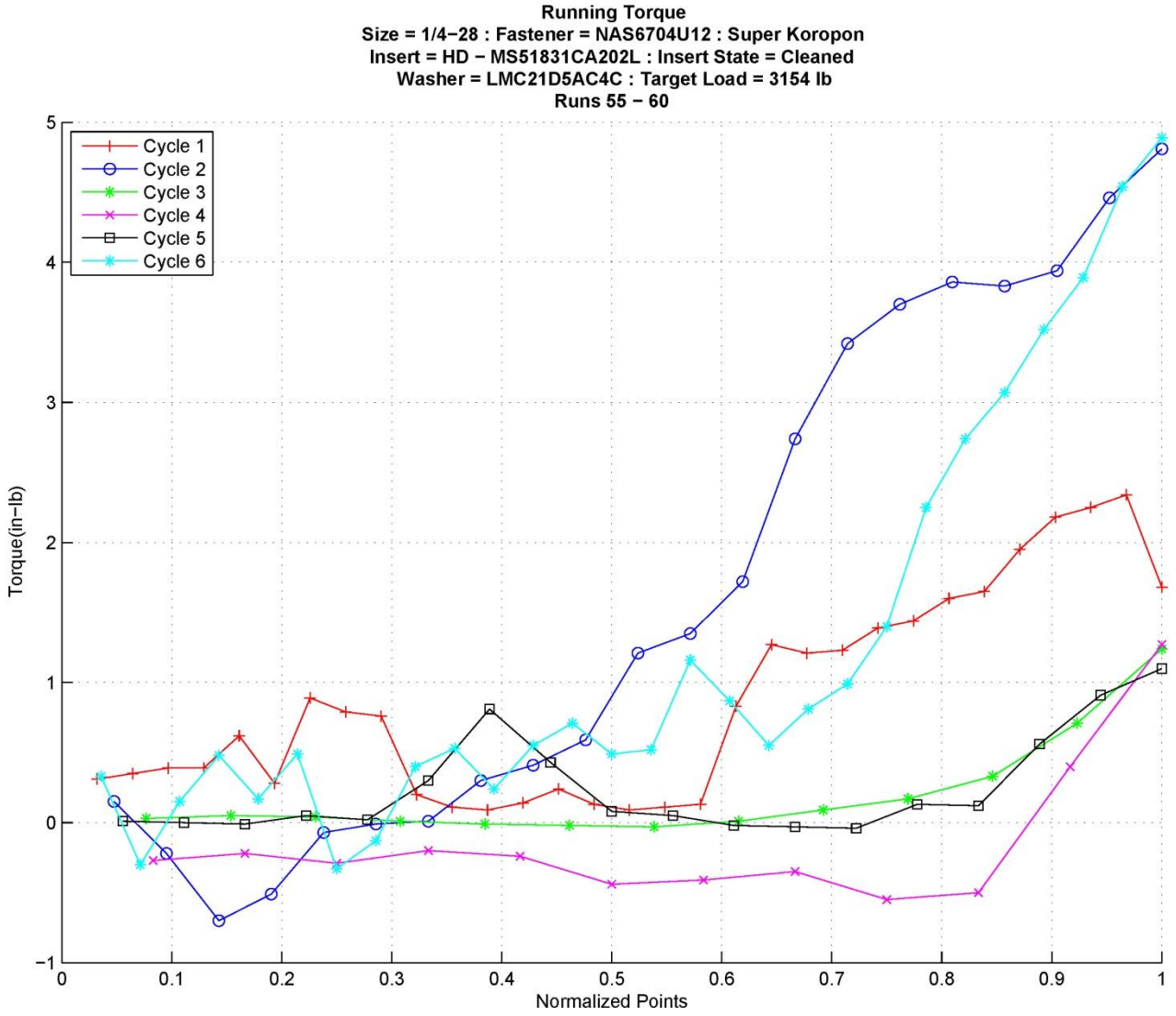

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = ExHD − MS51832CA202L : Insert State = Cleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 25 − 30
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
6
5
4
3
2
1
0
−1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

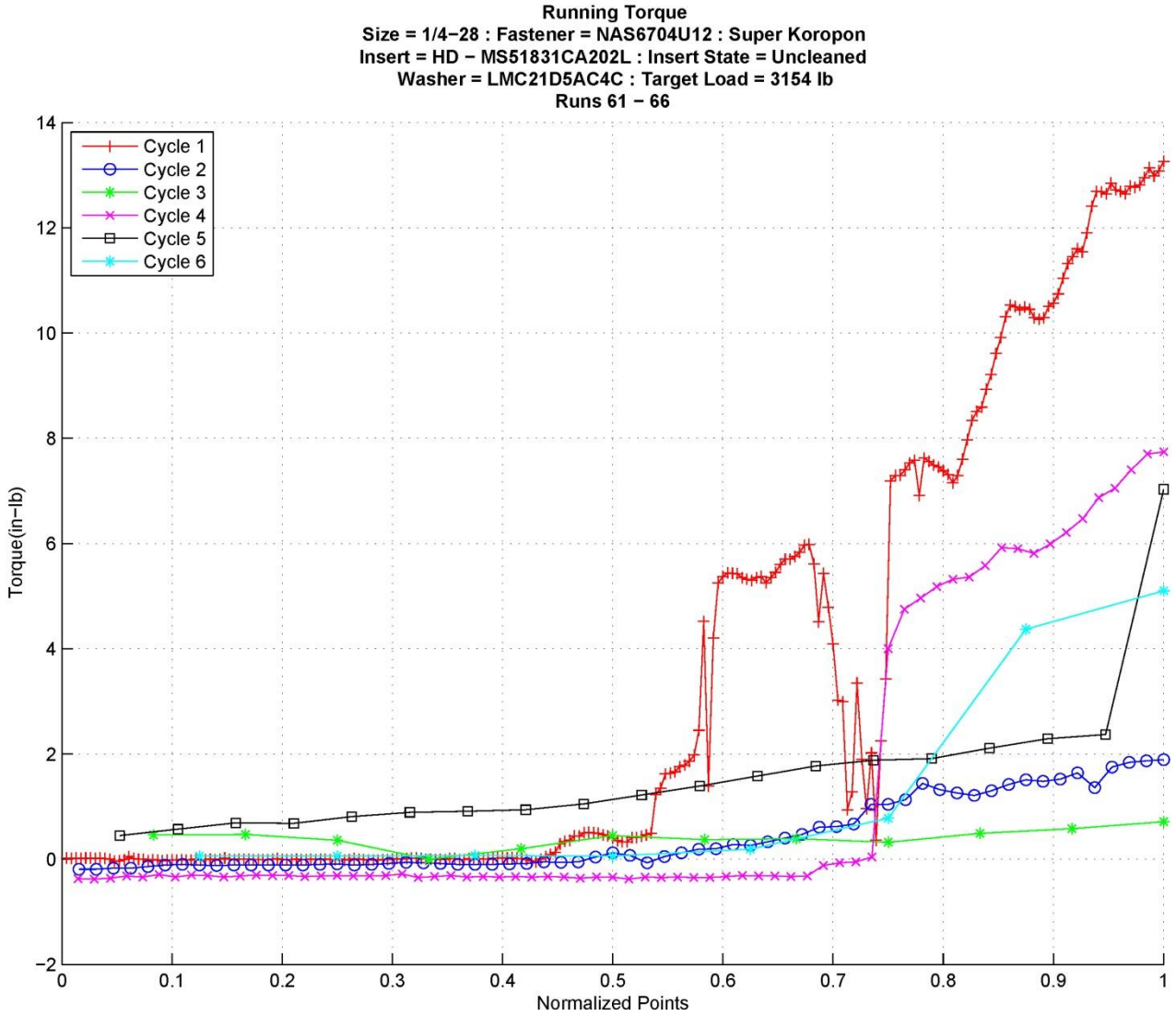

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = ExHD − MS51832CA202L : Insert State = Cleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 31 − 36
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
8
7
6
5
4
3
2
1
0
−1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

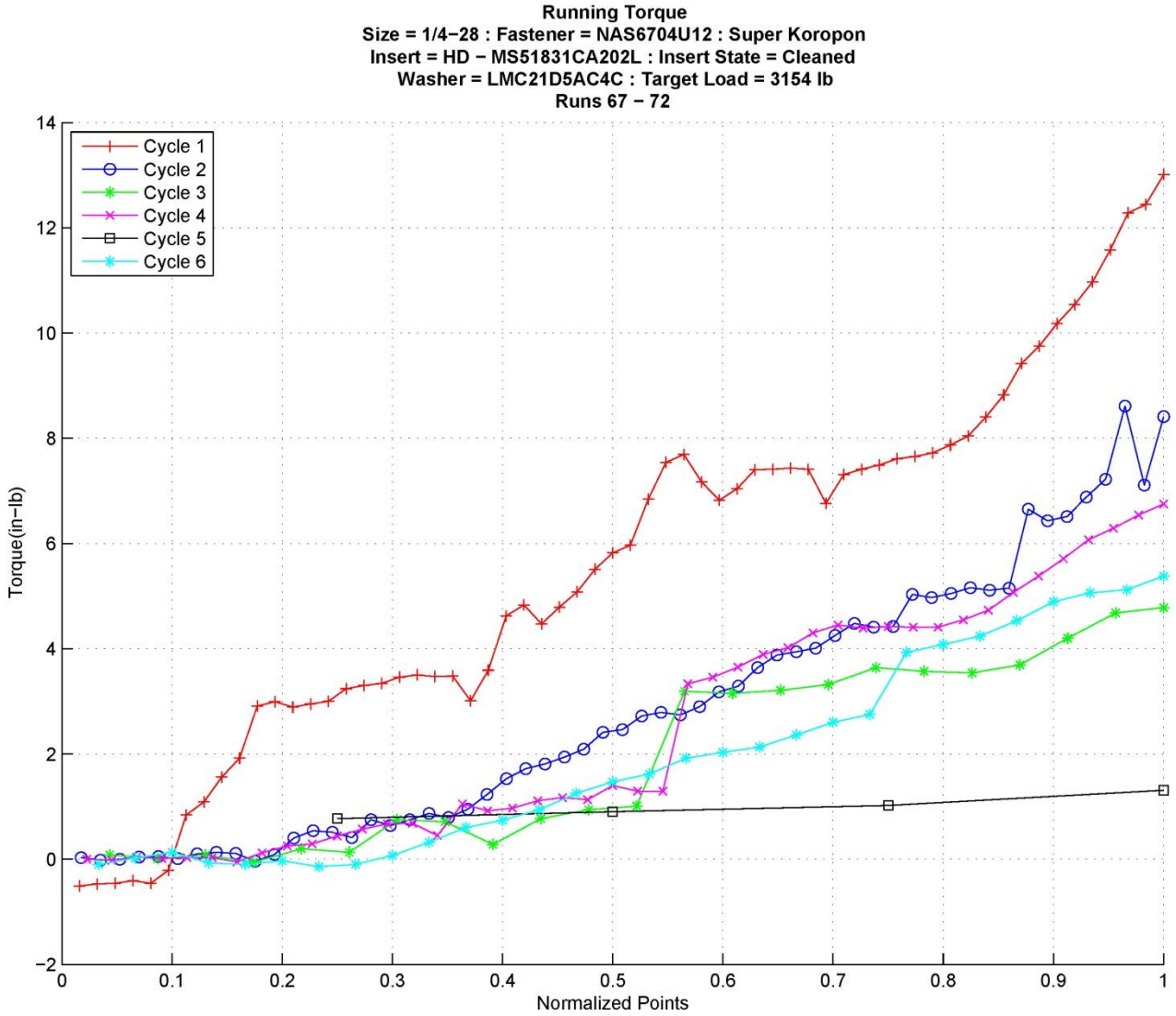

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = HD − MS51831CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 37 − 42
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
7
6
5
4
3
2
1
0
−1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

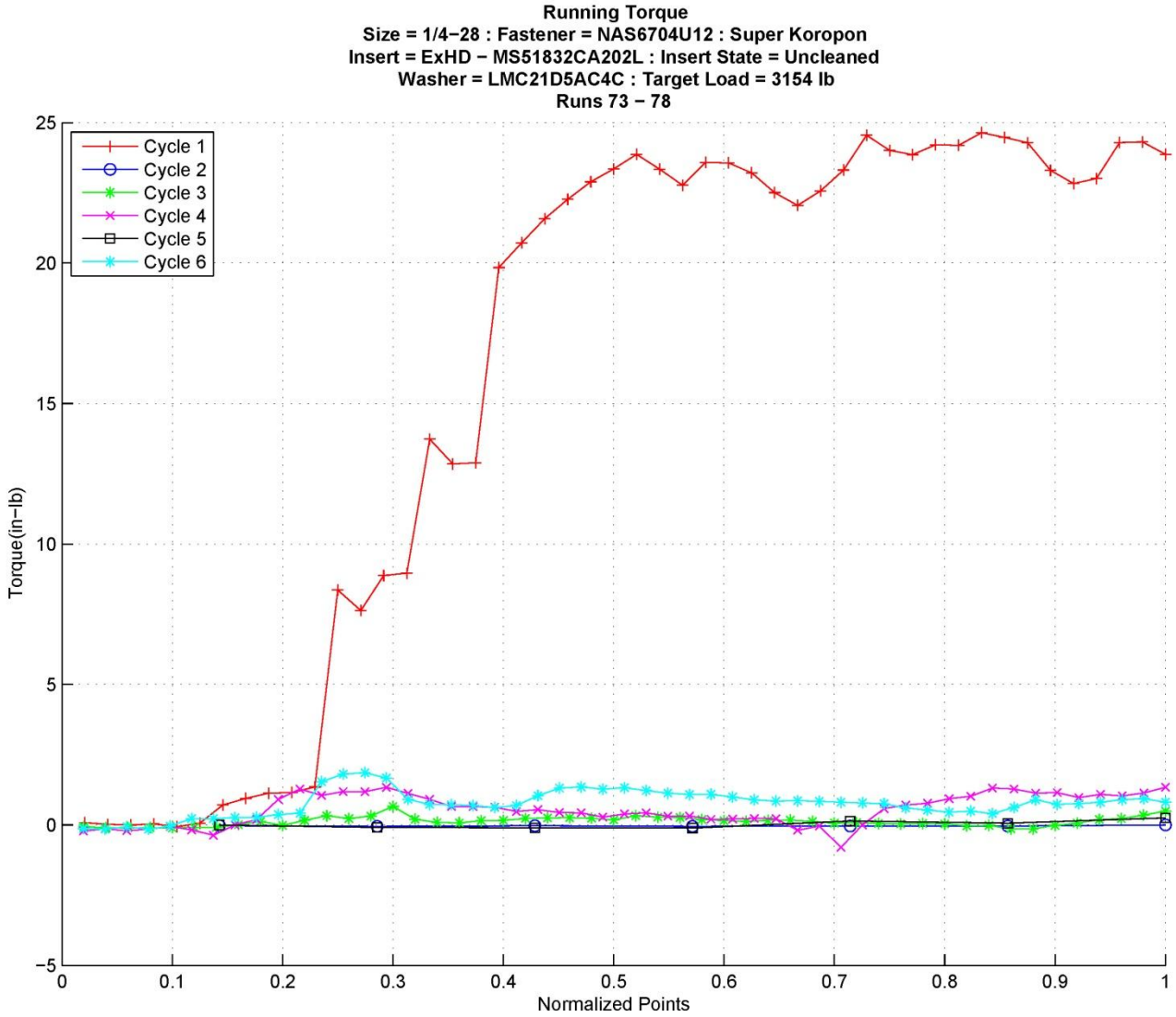

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = HD − MS51831CA202L : Insert State = Cleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 43 − 48
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
9
8
7
6
5
4
3
2
1
0
−1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

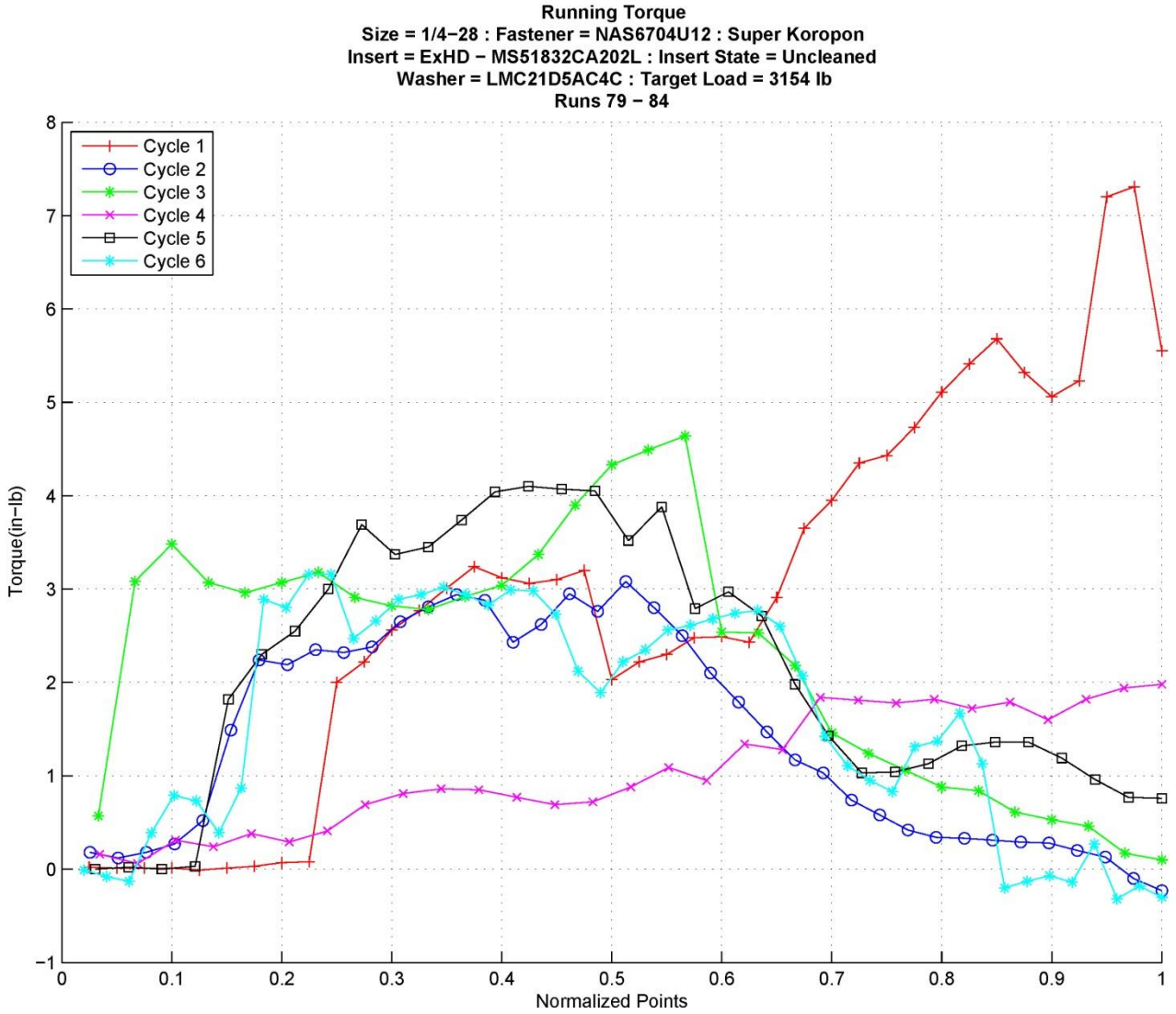

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = HD − MS51831CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 49 − 54
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
9
8
7
6
5
4
3
2
1
0
−1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

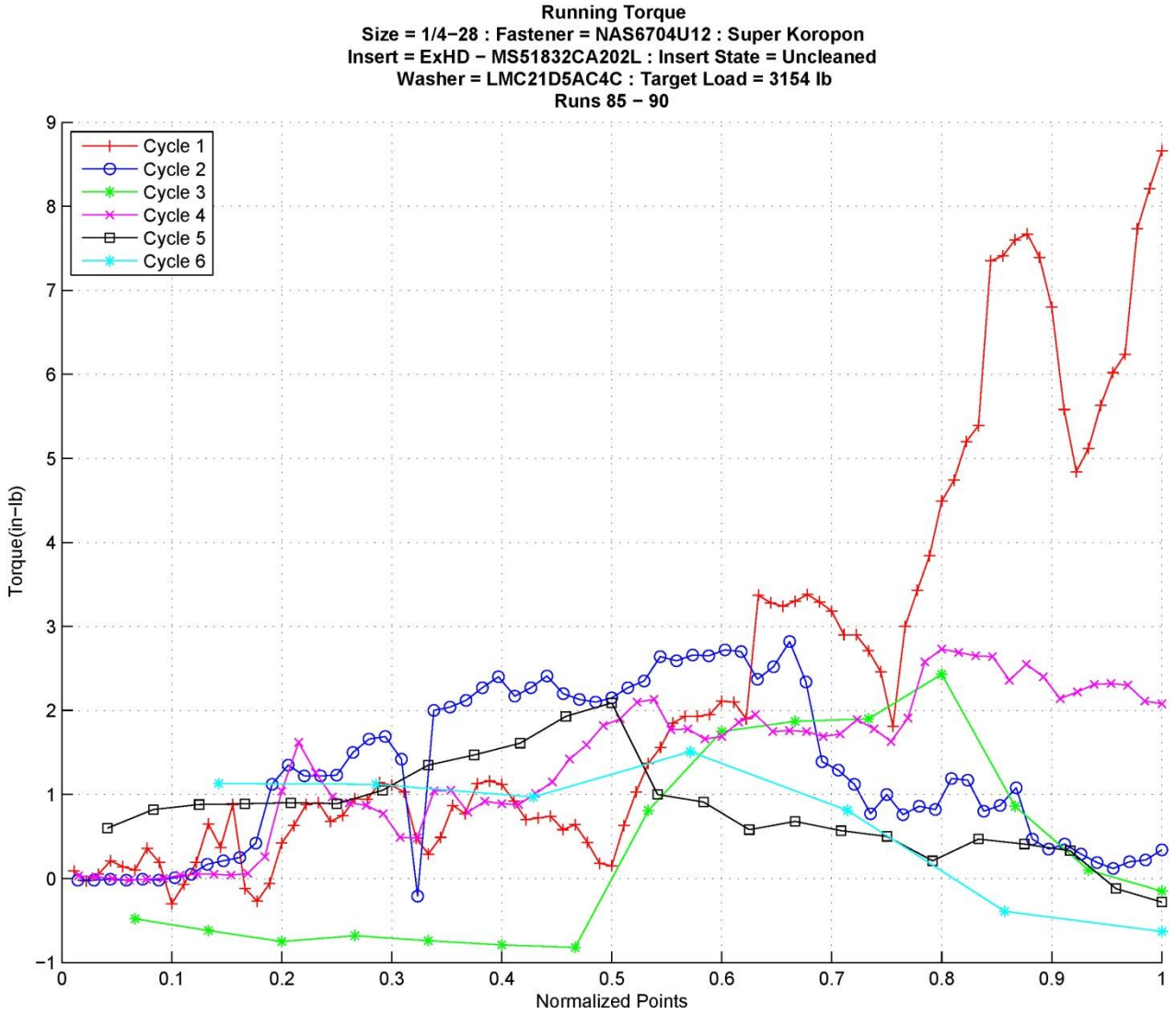

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = HD − MS51831CA202L : Insert State = Cleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 55 − 60
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
5
4
3
2
1
0
−1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

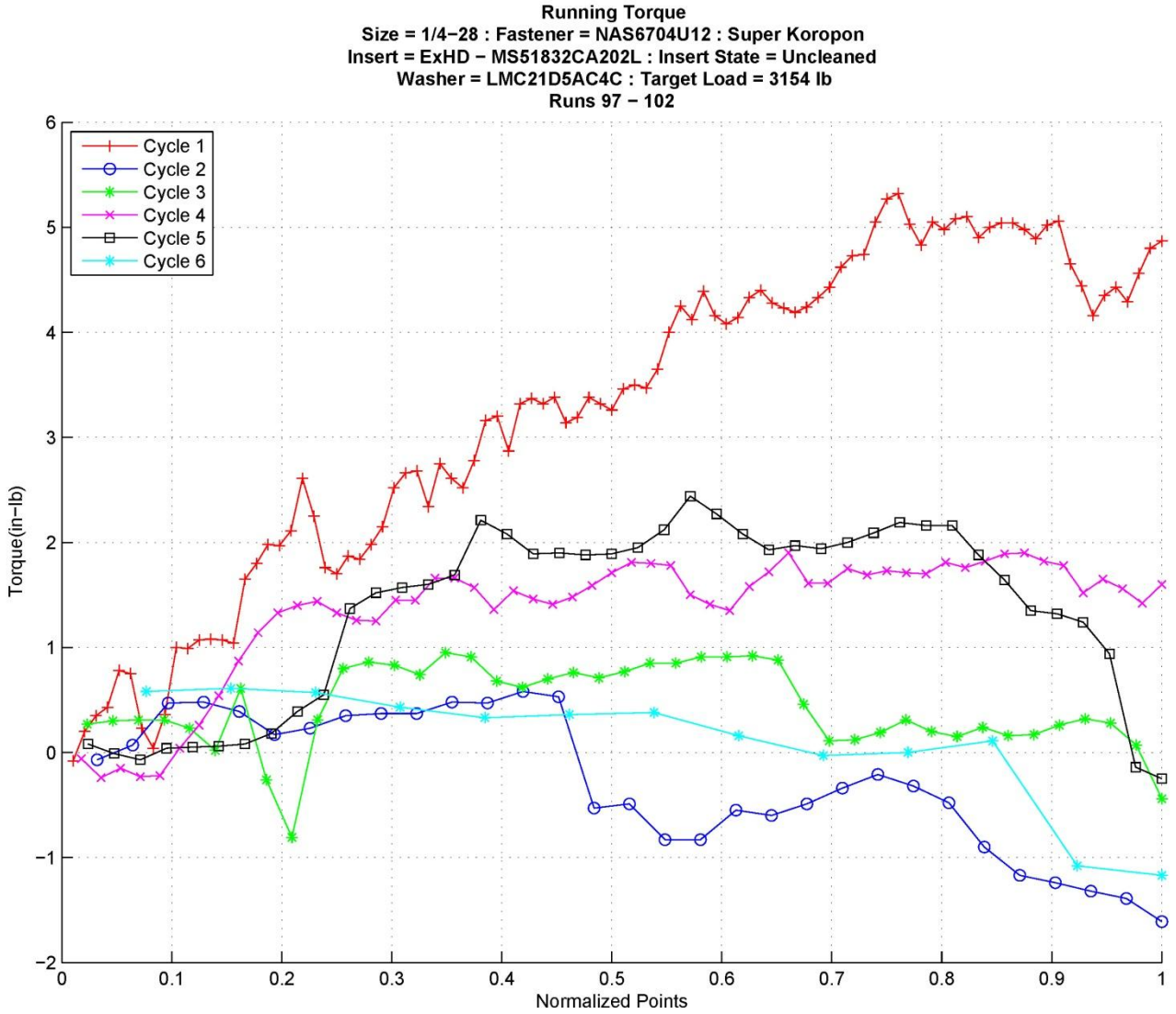

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = HD − MS51831CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 61 − 66
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
14
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

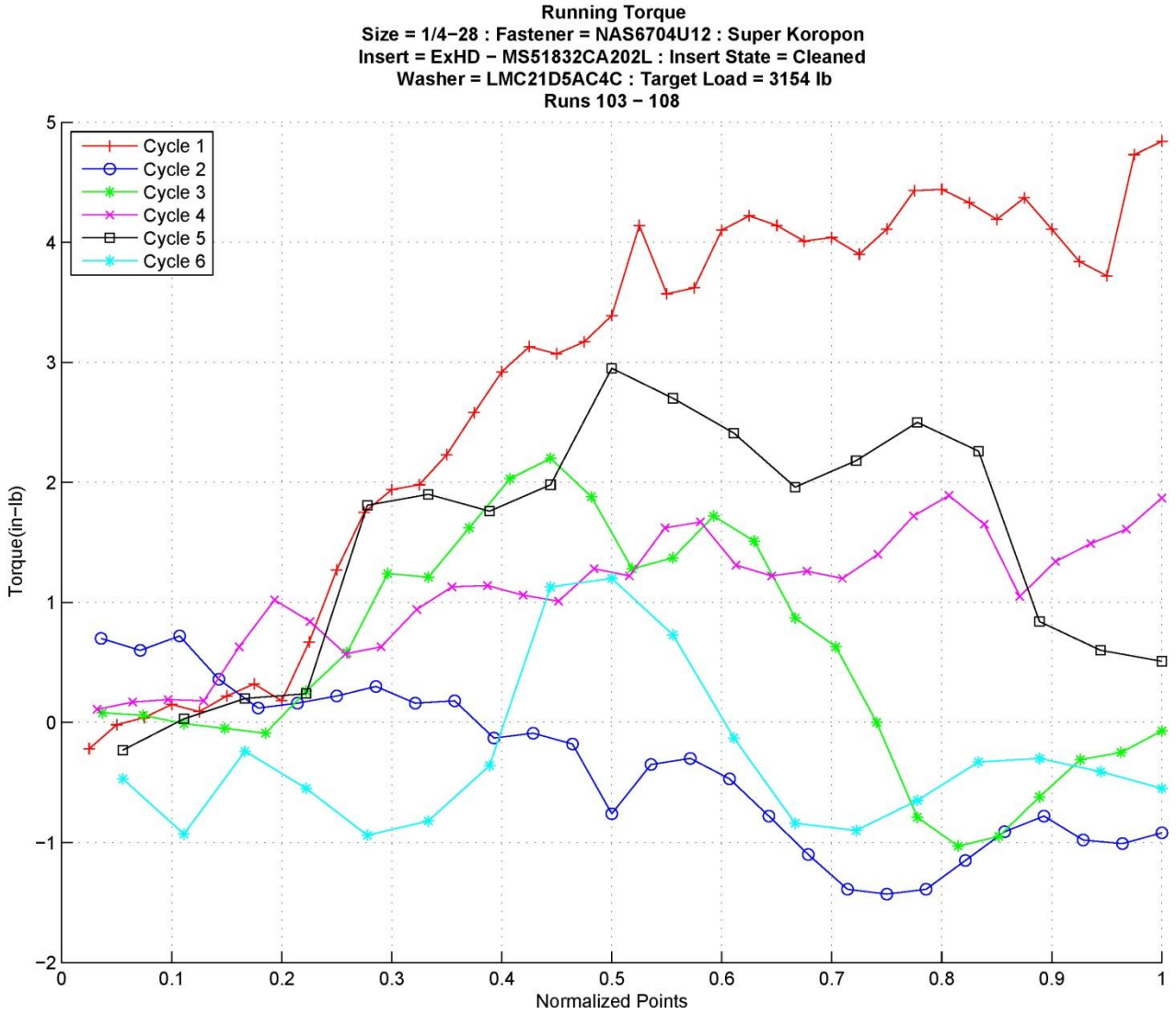

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = HD − MS51831CA202L : Insert State = Cleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 67 − 72
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
14
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

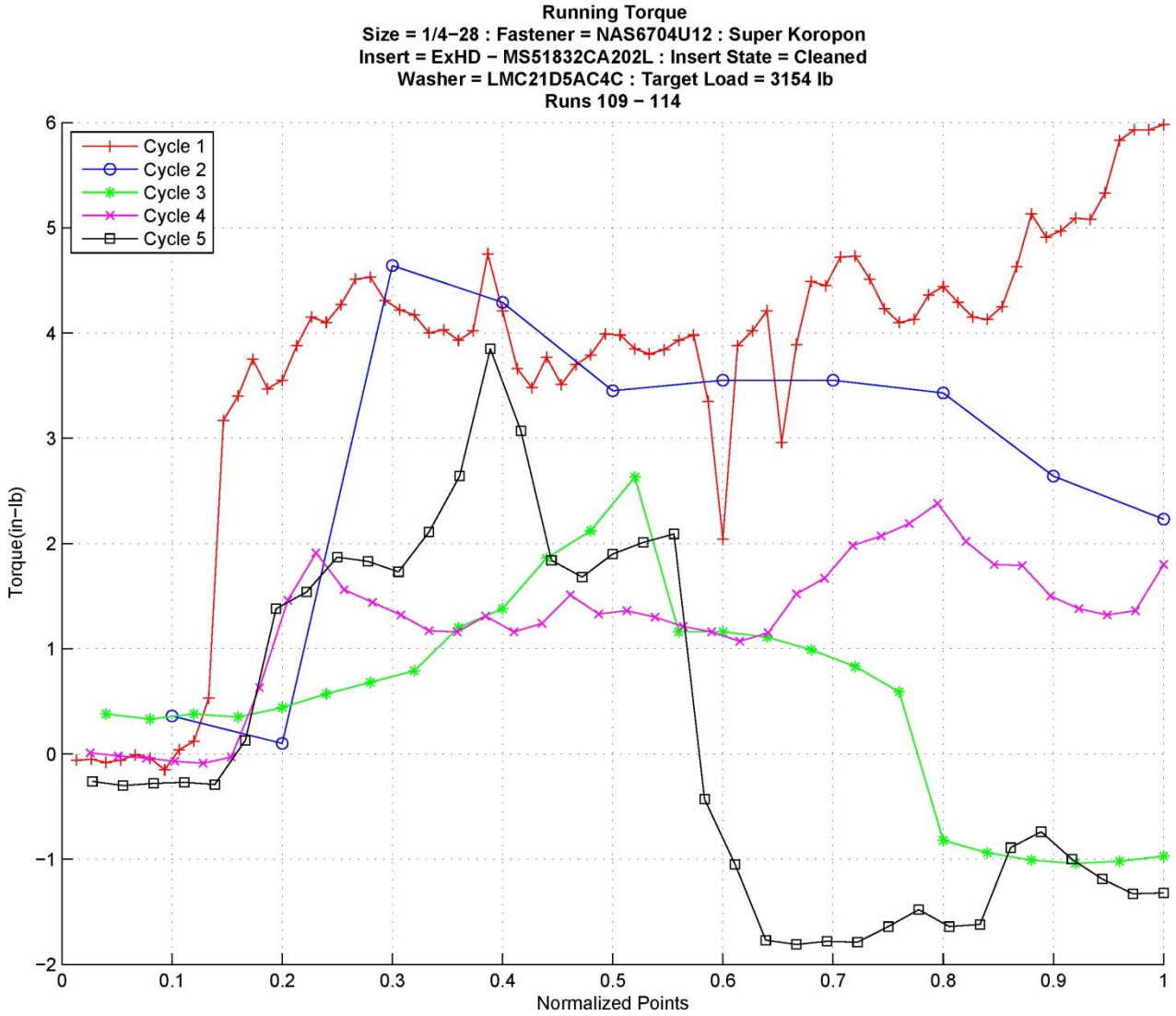

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = ExHD − MS51832CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 73 − 78
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
25
20
15
10
5
0
−5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

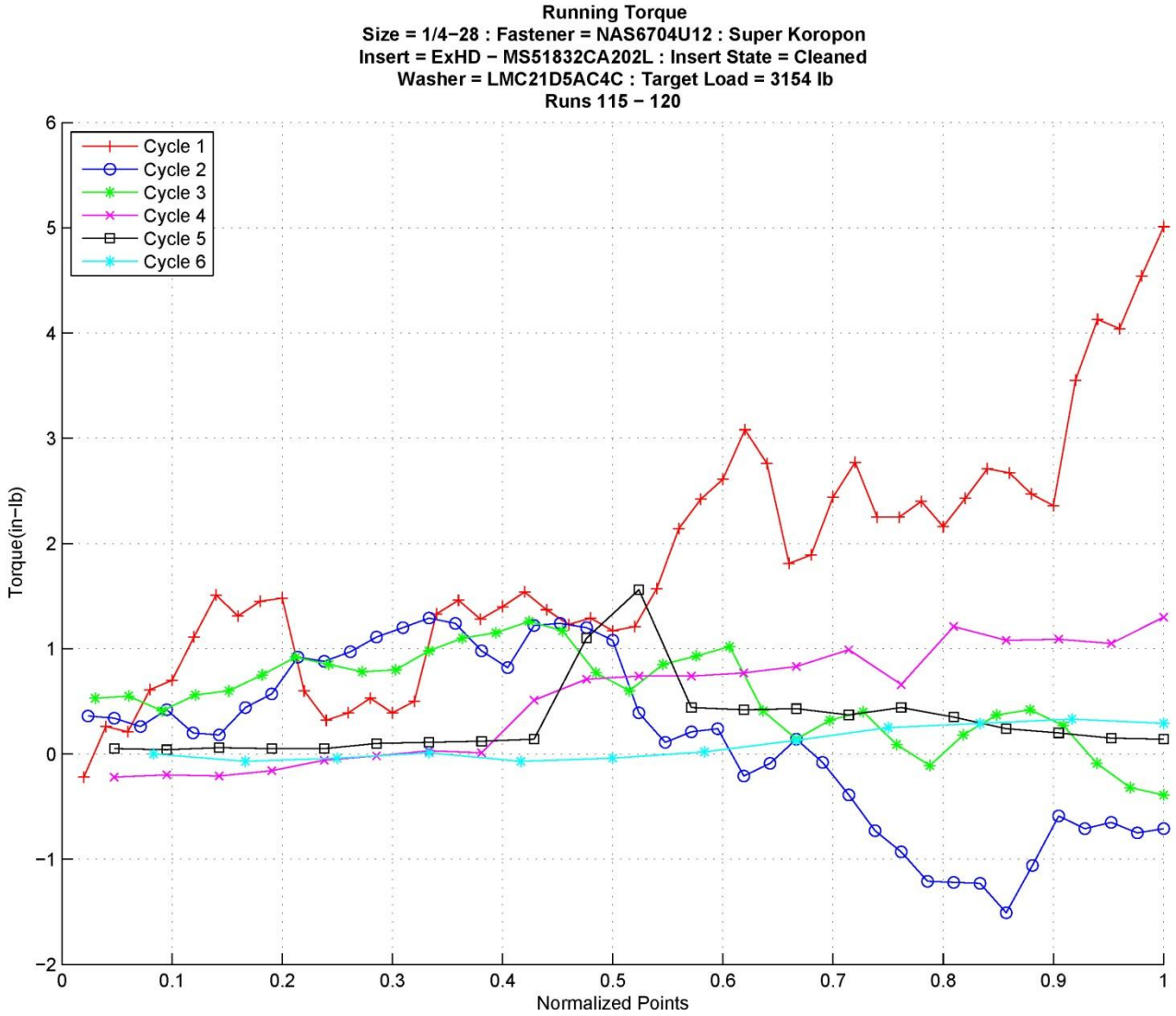

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = ExHD − MS51832CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 79 − 84
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
8
7
6
5
4
3
2
1
0
−1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

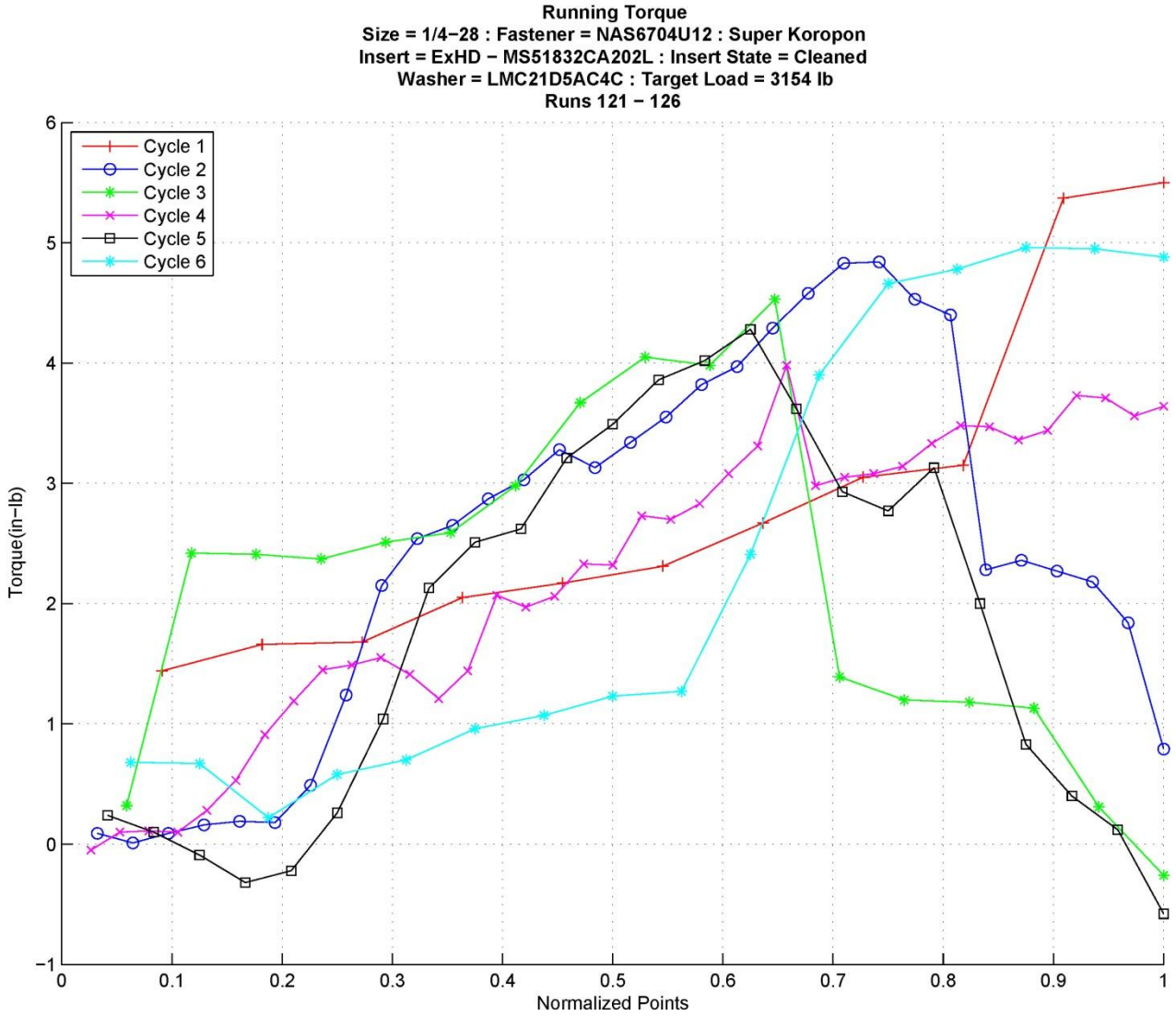

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = ExHD − MS51832CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 85 − 90
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
9
8
7
6
5
4
3
2
1
0
−1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

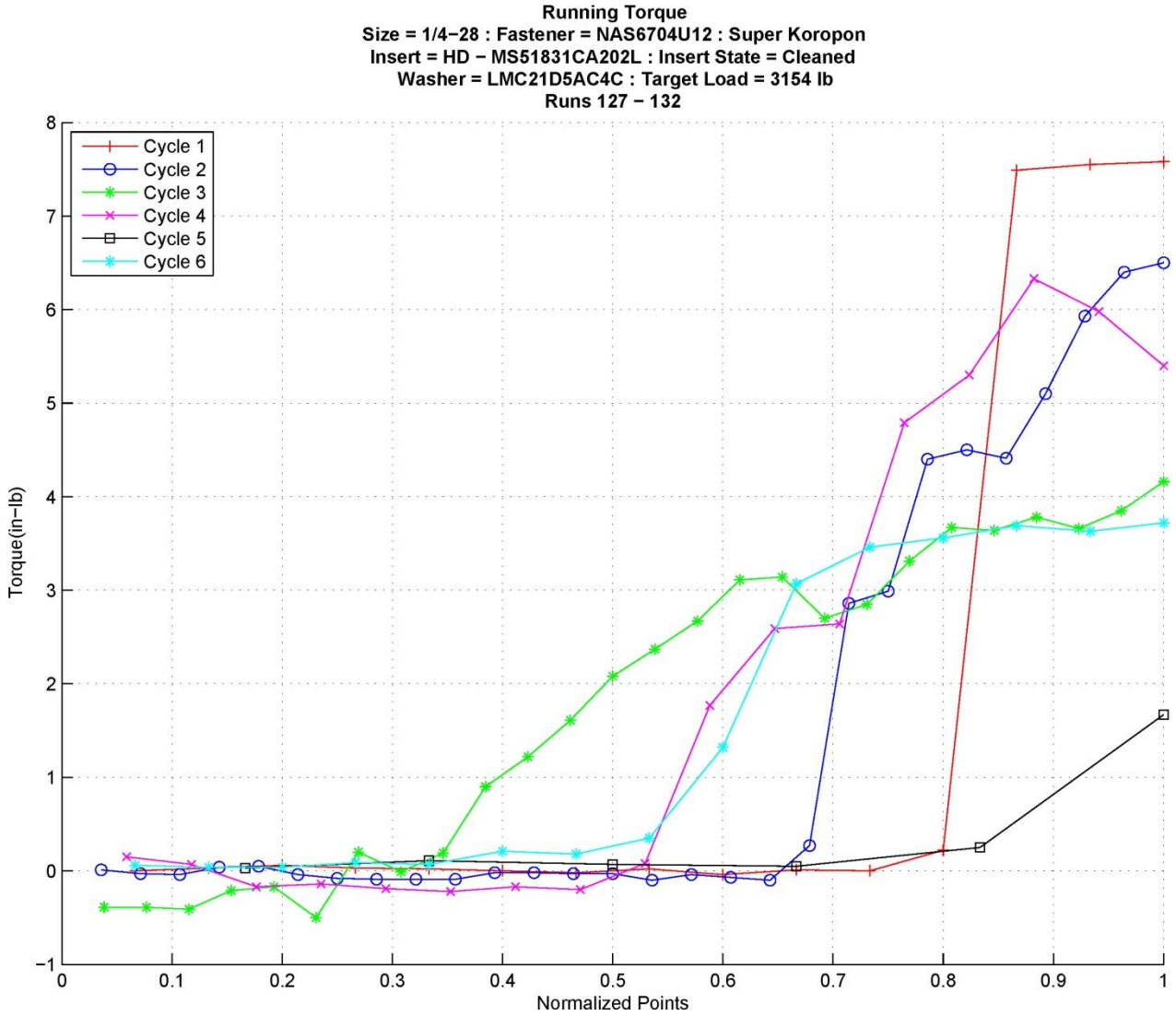

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = ExHD − MS51832CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 97 − 102
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
6
5
4
3
2
1
0
−1
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

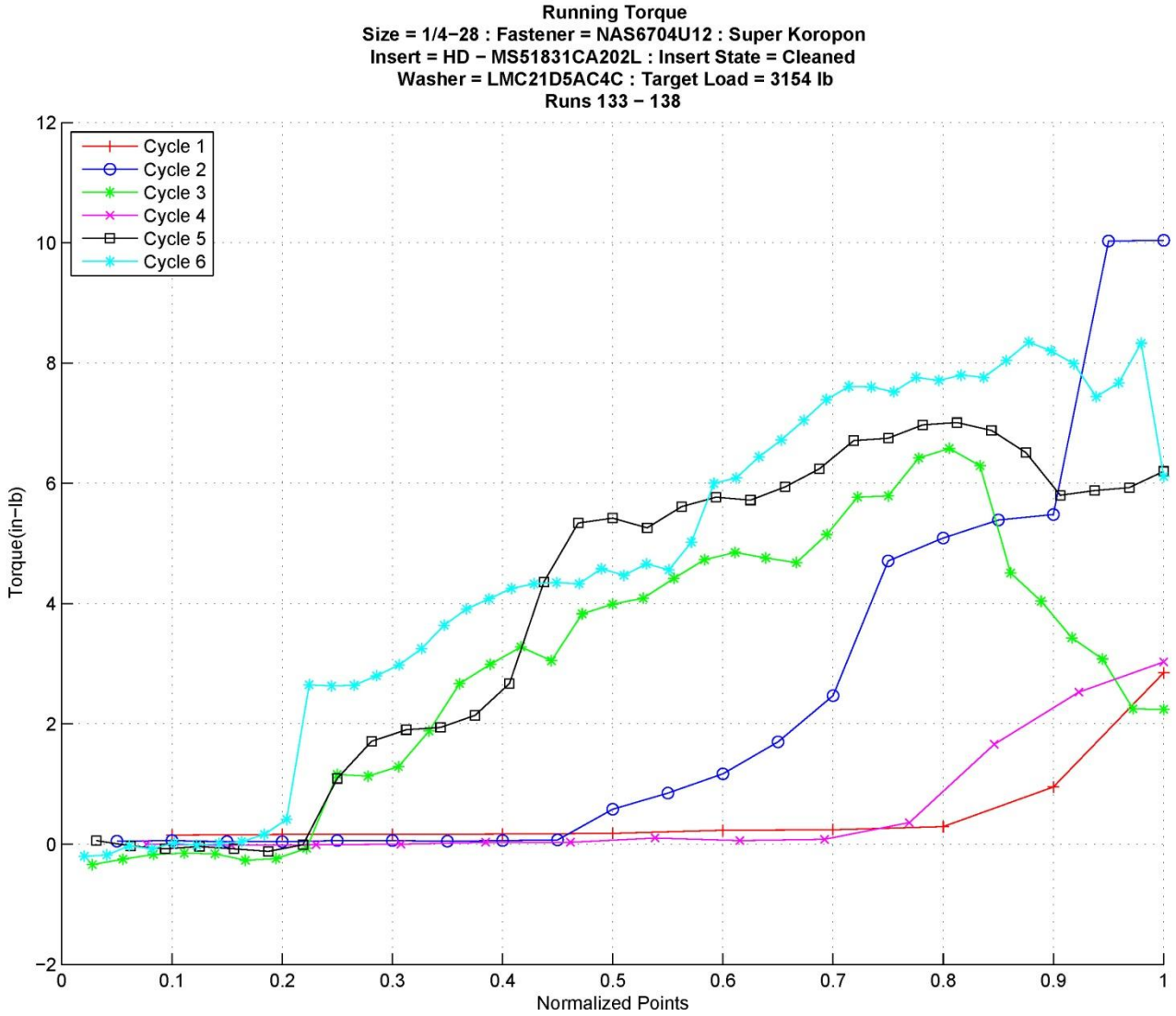

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = ExHD − MS51832CA202L : Insert State = Cleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 103 − 108
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
5
4
3
2
1
0
−1
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

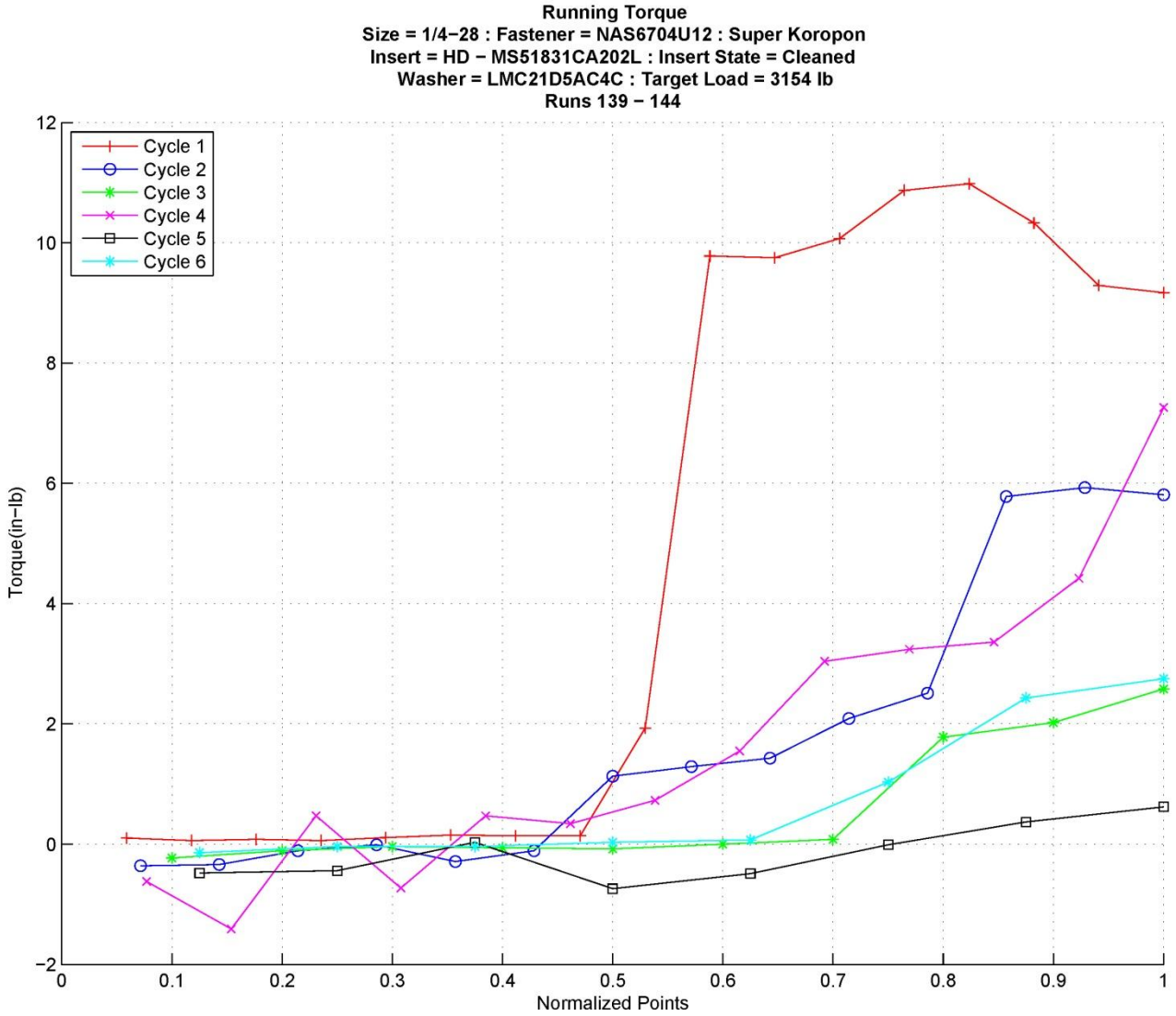

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = ExHD − MS51832CA202L : Insert State = Cleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 109 − 114
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Torque(in−lb)
Normalized Points
6
5
4
3
2
1
0
−1
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

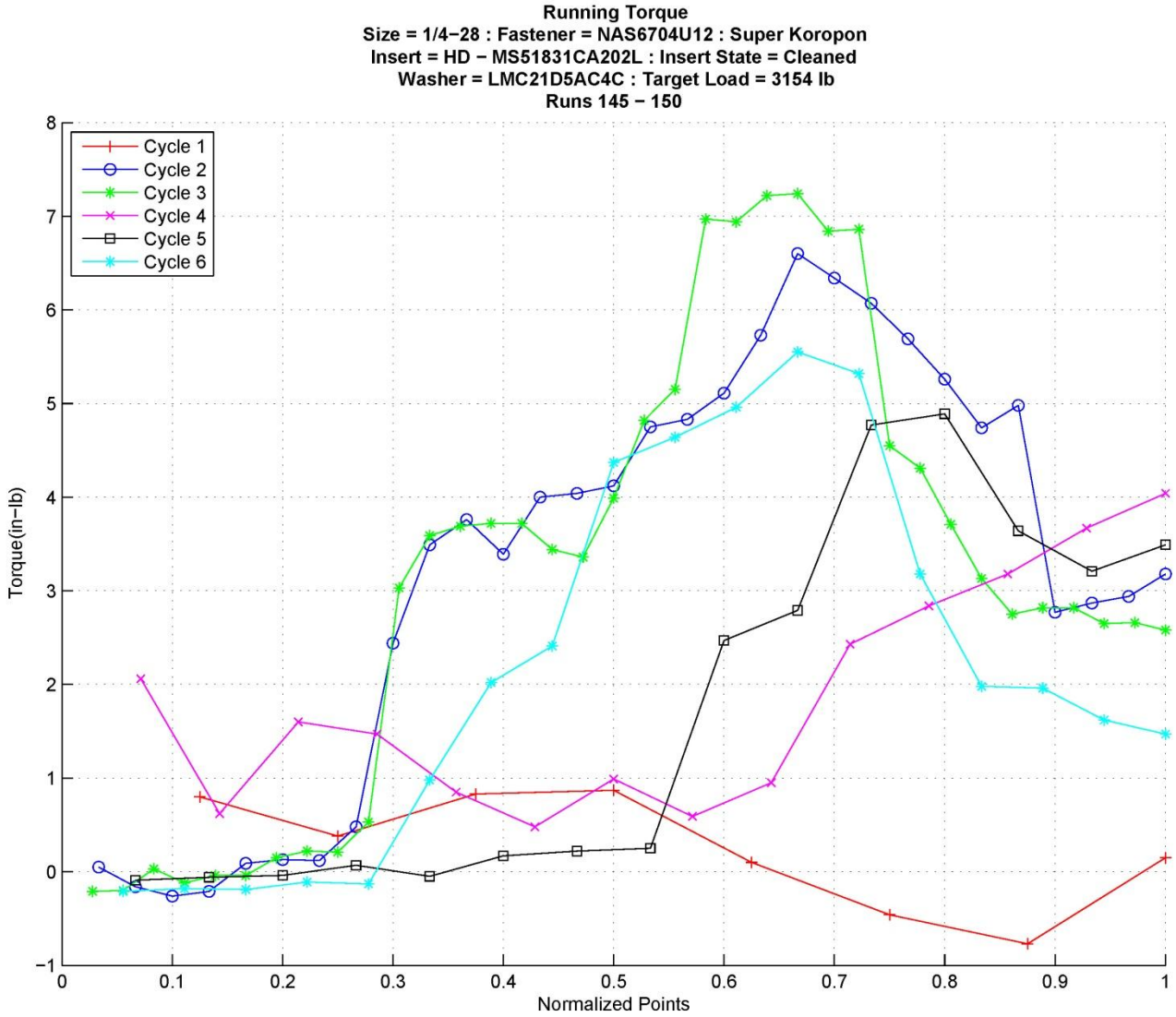

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = ExHD − MS51832CA202L : Insert State = Cleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 115 − 120
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
6
5
4
3
2
1
0
−1
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

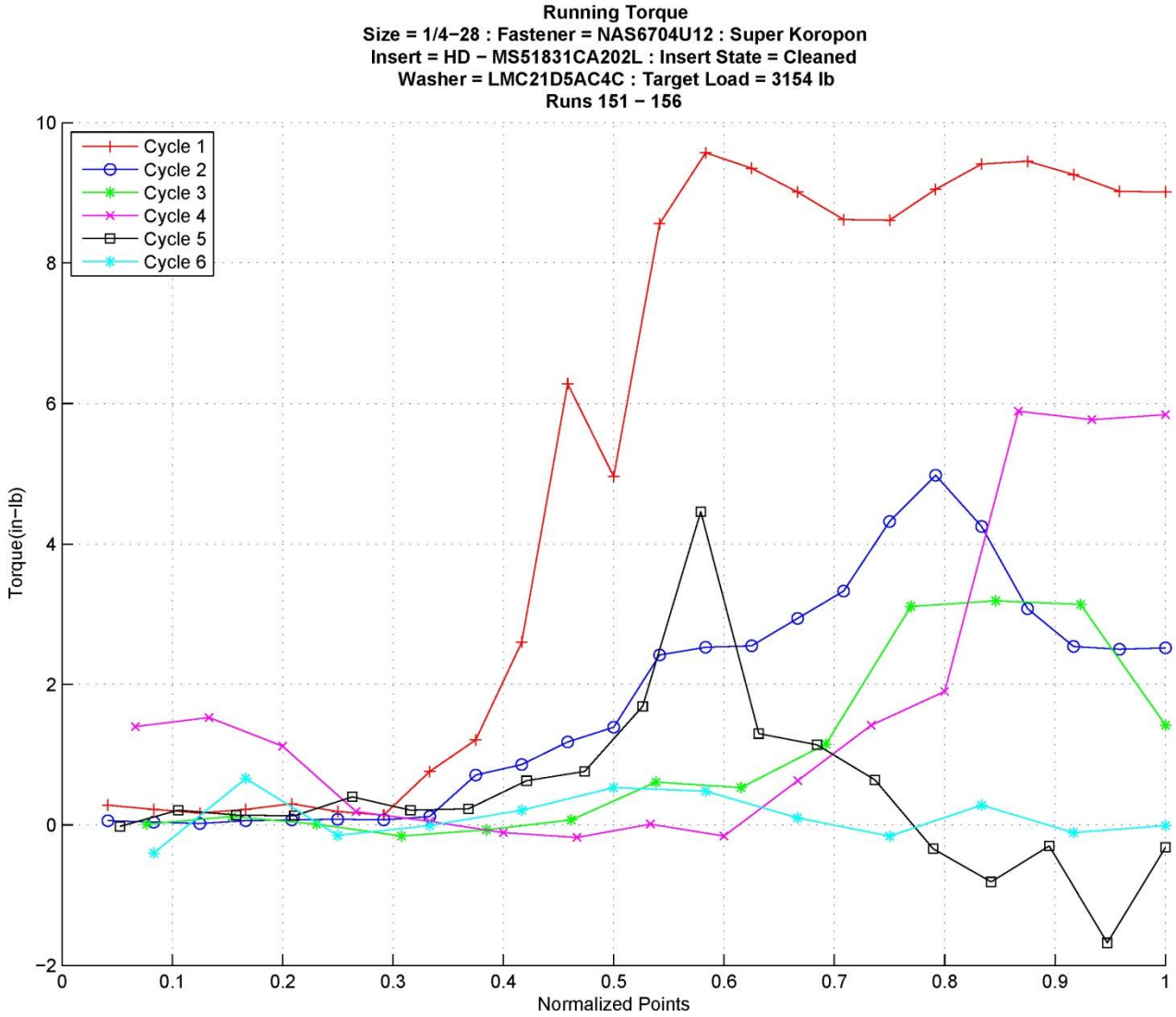

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = ExHD − MS51832CA202L : Insert State = Cleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 121 − 126
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
6
5
4
3
2
1
0
−1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

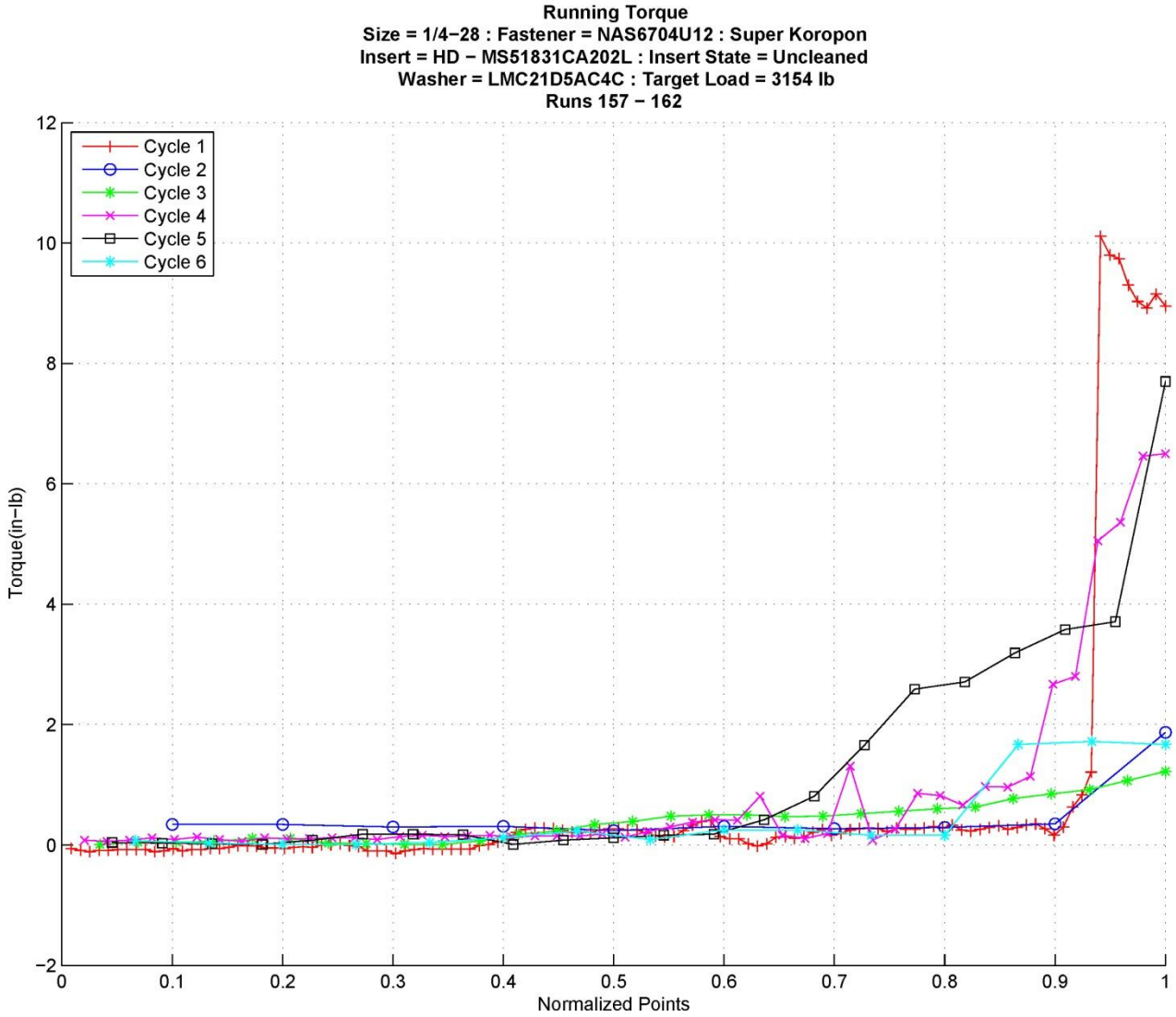

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = HD − MS51831CA202L : Insert State = Cleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 127 − 132
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
8
7
6
5
4
3
2
1
0
−1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

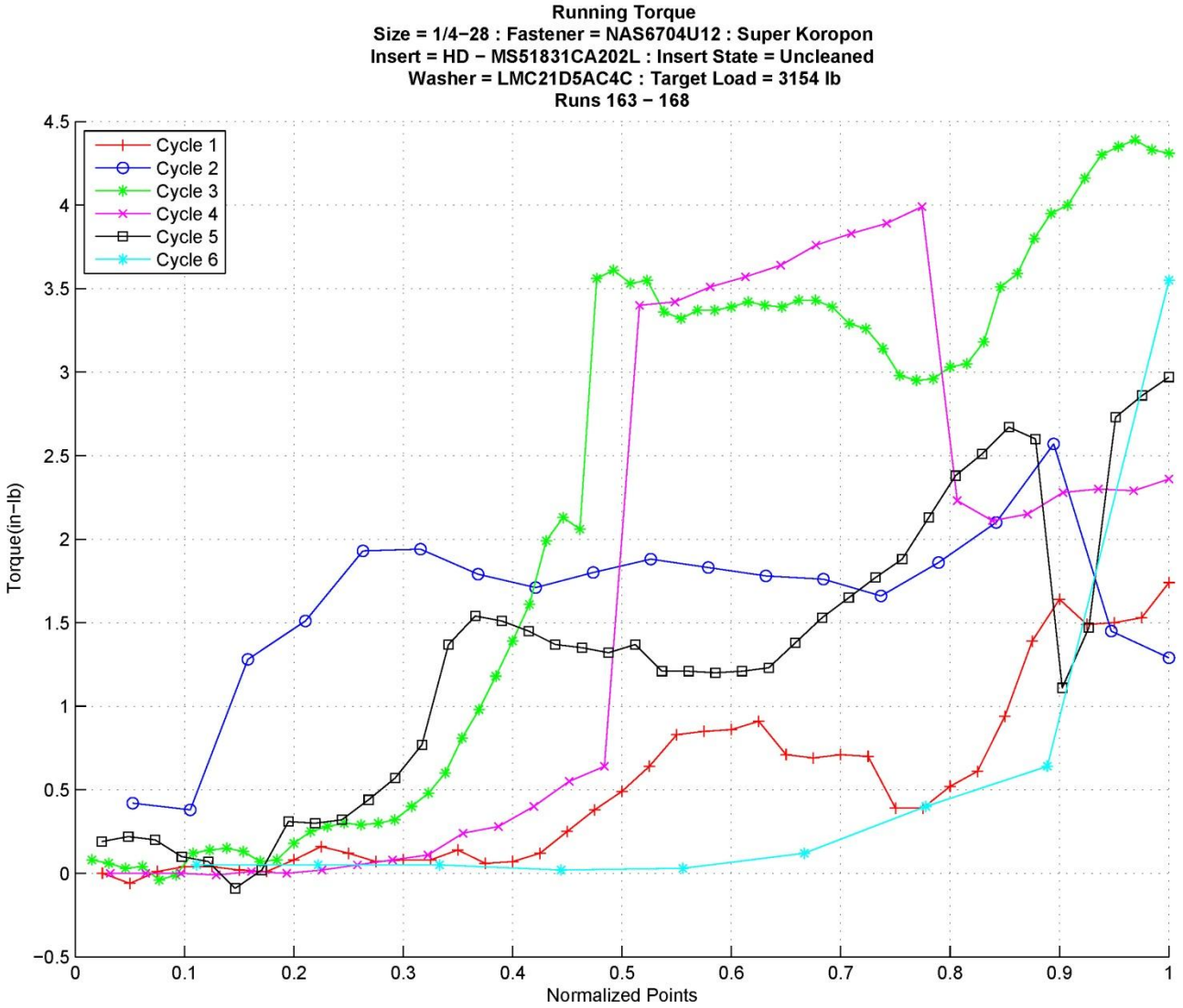

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = HD − MS51831CA202L : Insert State = Cleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 133 − 138
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

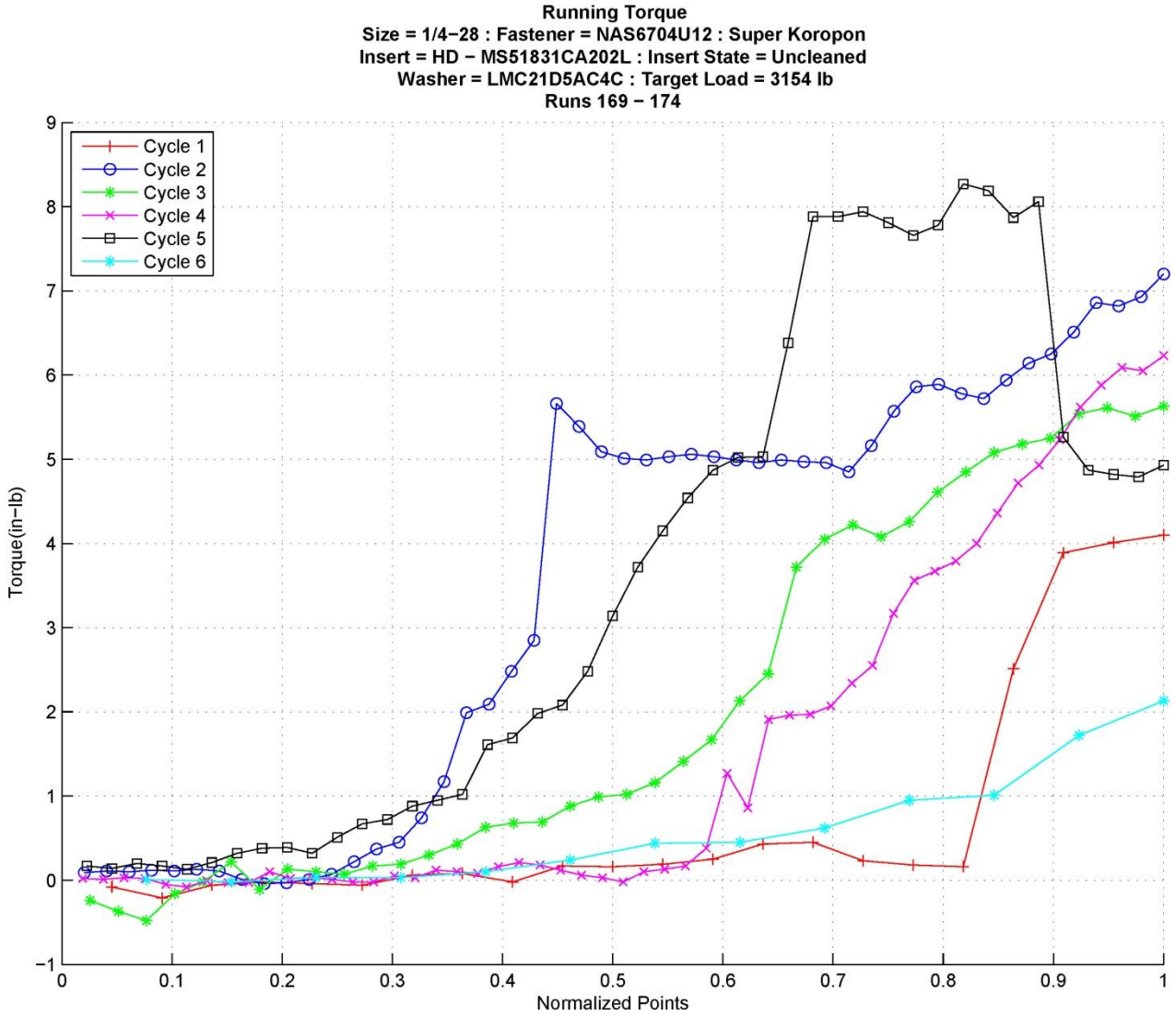

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = HD − MS51831CA202L : Insert State = Cleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 139 − 144
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

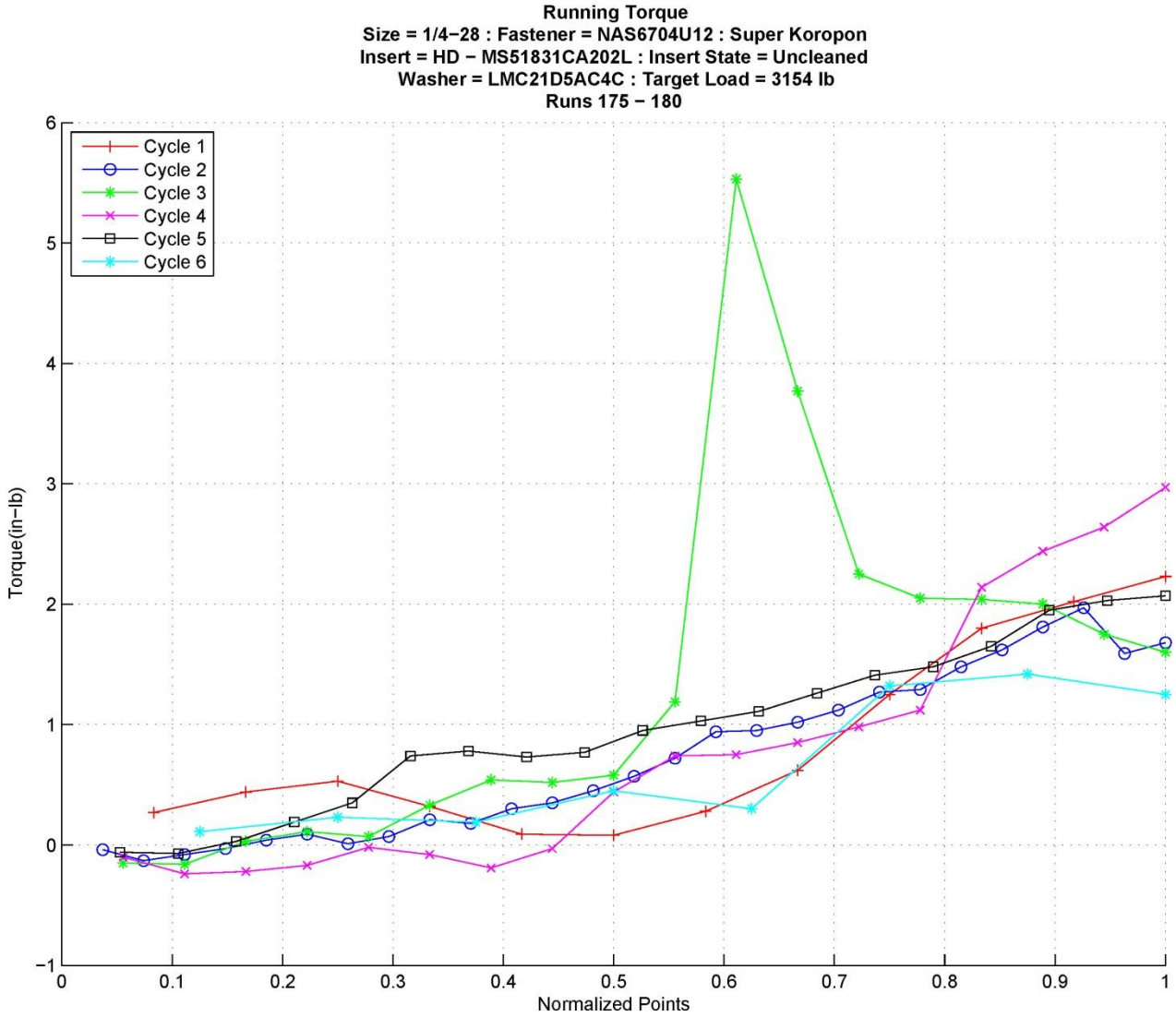

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = HD − MS51831CA202L : Insert State = Cleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 145 − 150
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
8
7
6
5
4
3
2
1
0
−1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

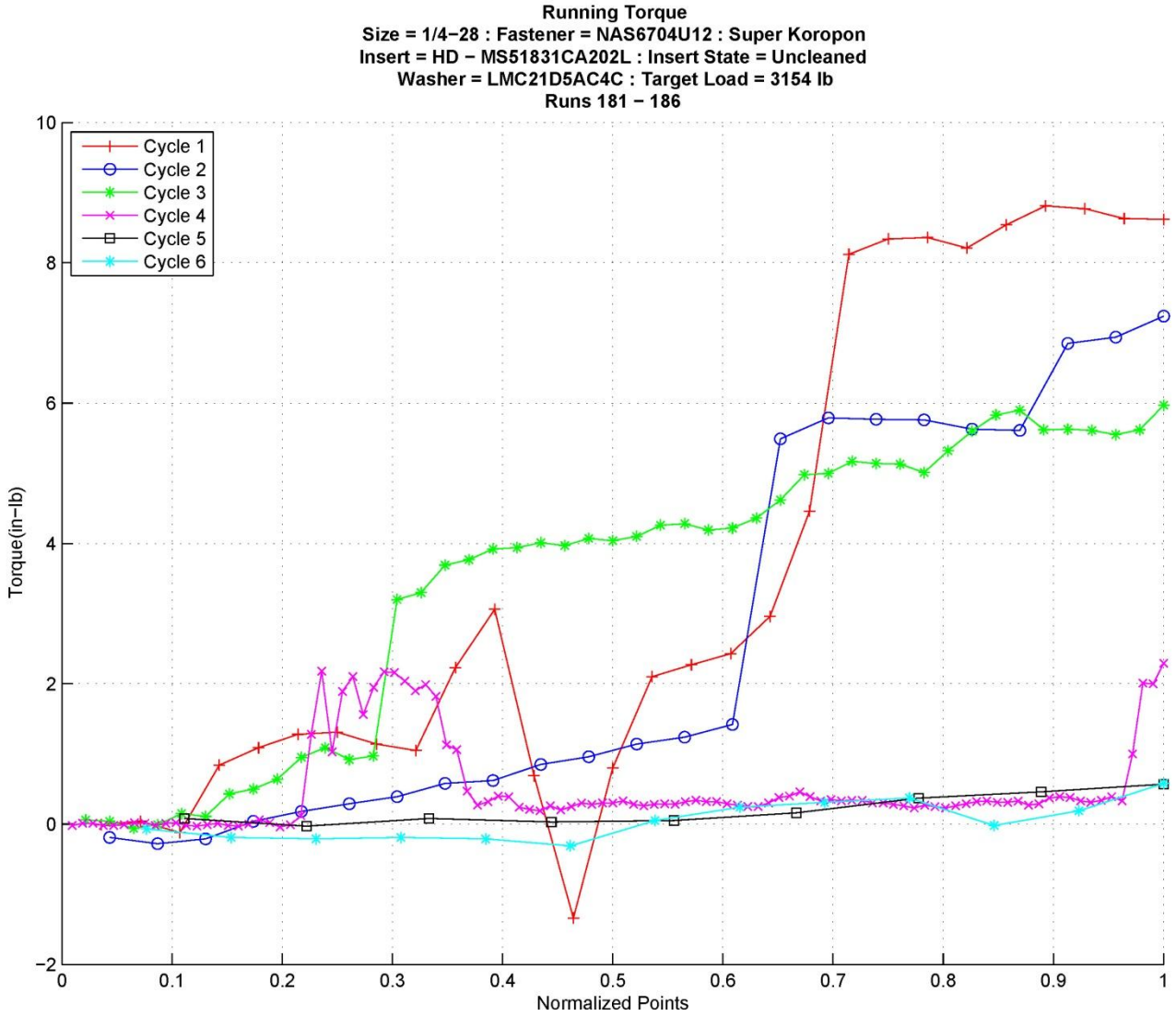

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = HD − MS51831CA202L : Insert State = Cleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 151 − 156
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = HD − MS51831CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 157 − 162
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = HD − MS51831CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 163 − 168
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
−0.5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

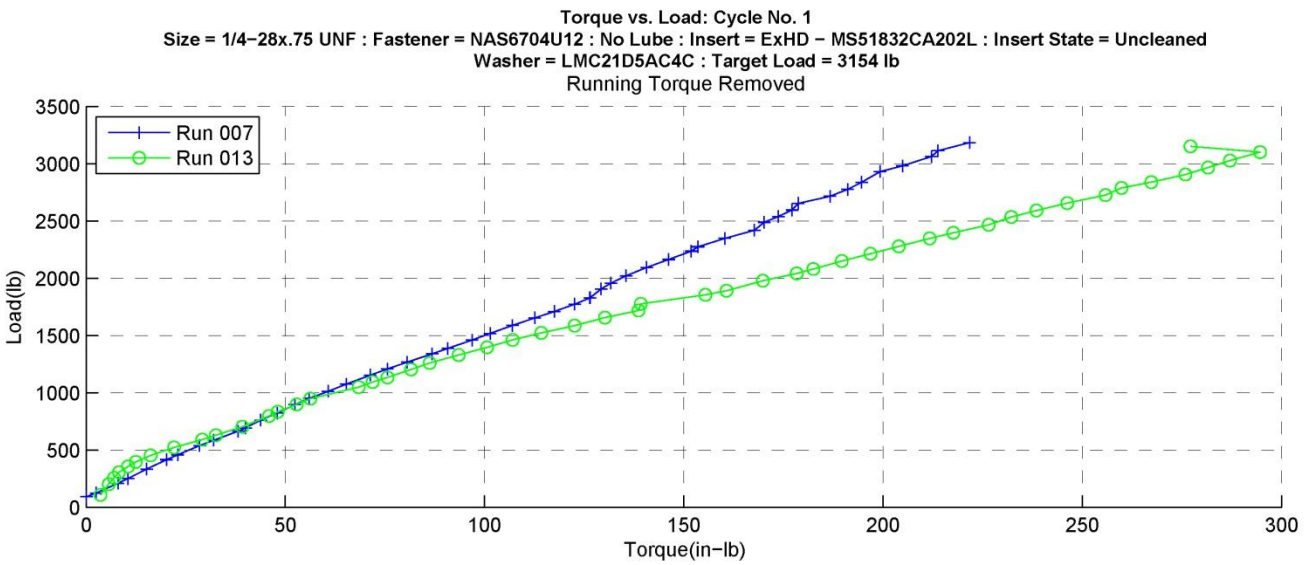

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = HD − MS51831CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 169 − 174
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
9
8
7
6
5
4
3
2
1
0
−1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

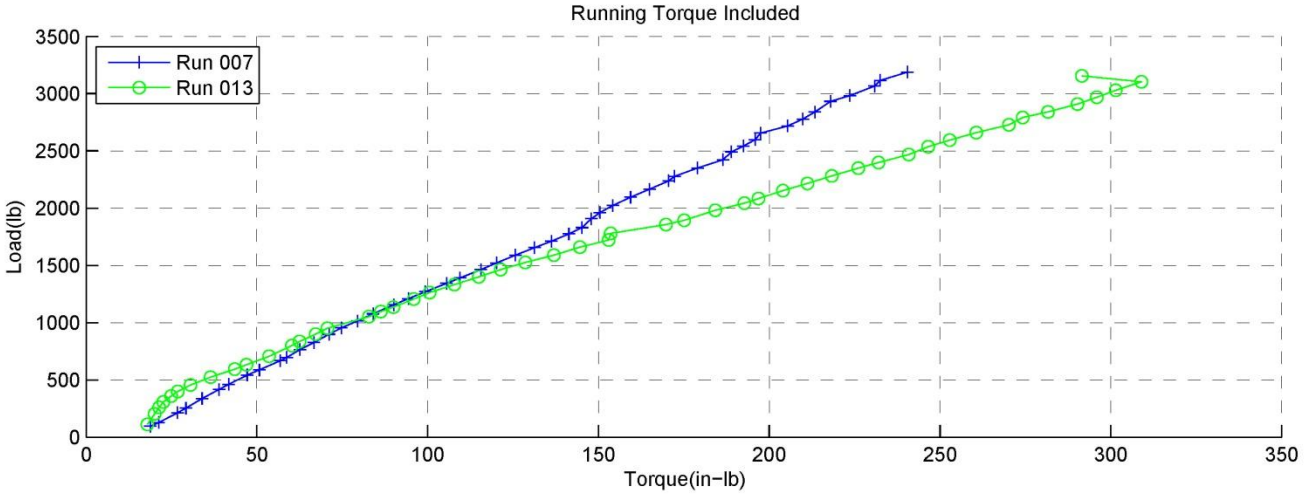

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = HD − MS51831CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 175 − 180
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
6
5
4
3
2
1
0
−1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

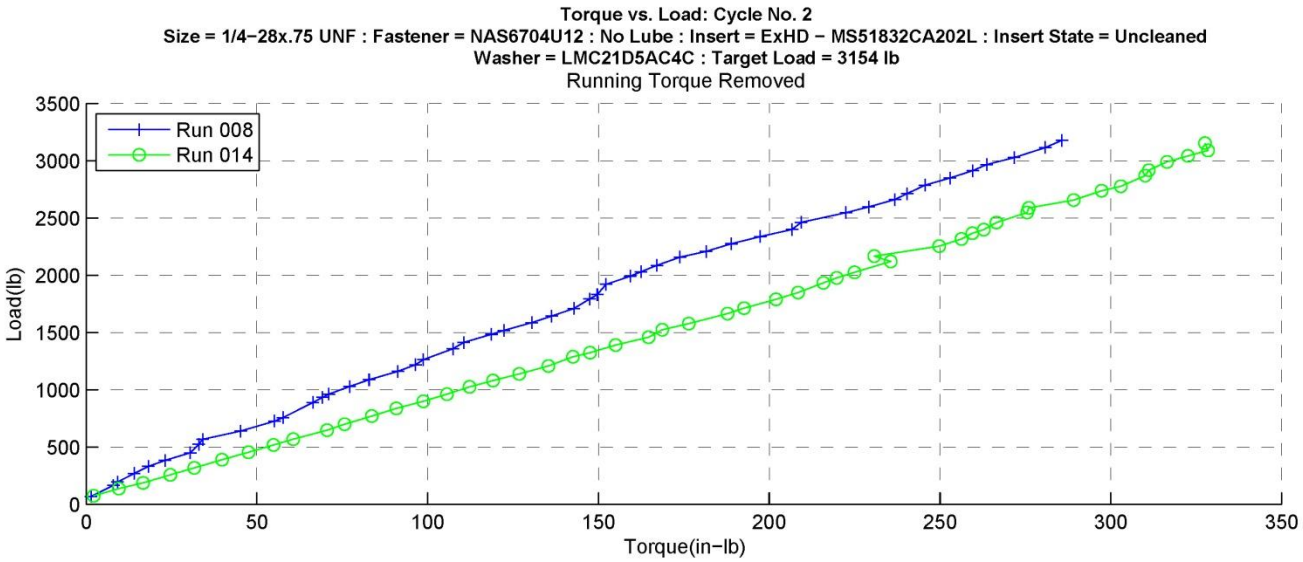

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon
Insert = HD − MS51831CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Runs 181 − 186
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Torque(in−lb)
Normalized Points
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

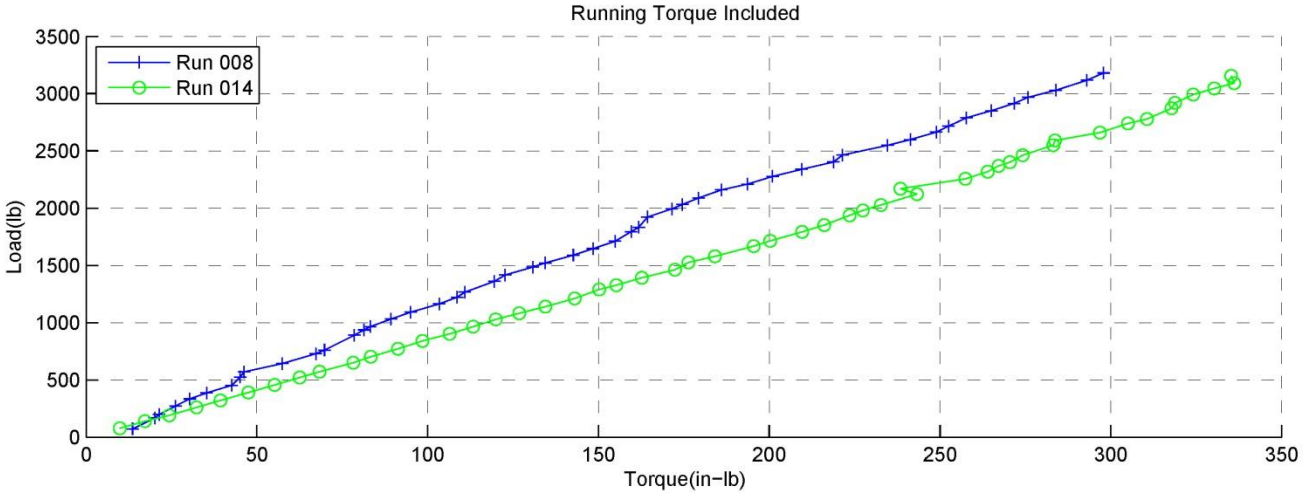
Appendix B:

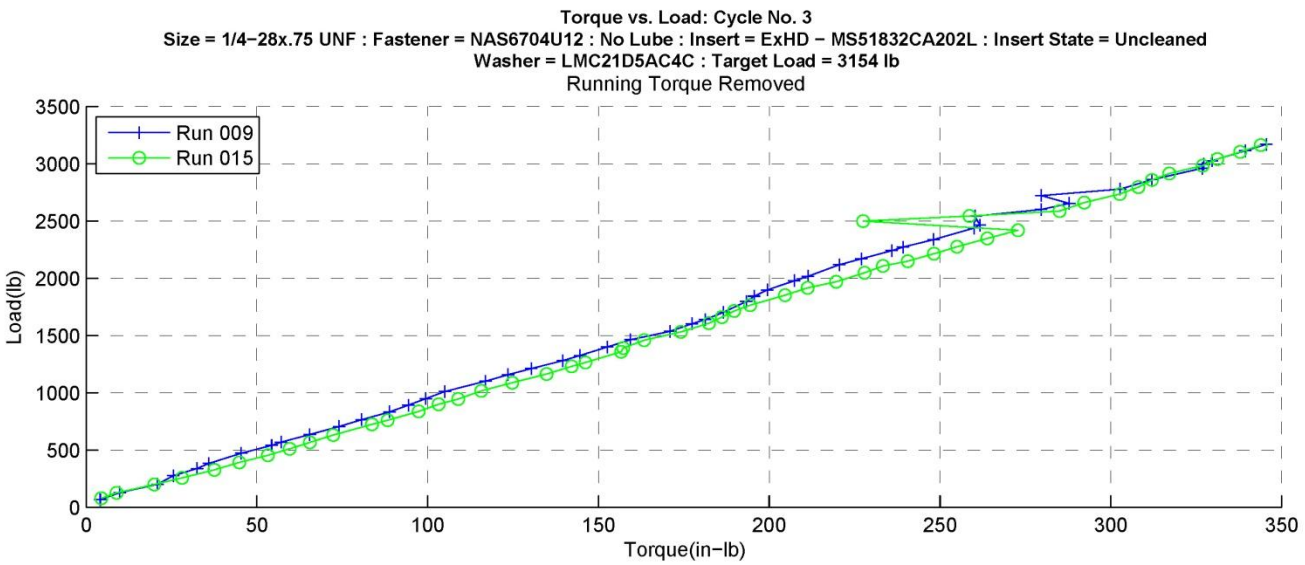
Section 1	¼-28 Dry Torque Tension Plots
Section 2	¼-28 Wet Torque Tension Plots
Section 3	¼-28 Dry Running Torque Plots
Section 4	¼-28 Wet Running Torque Plots
Section 5	¼-28 Dry Cycle Plots: Torque vs. Load
Section 6	¼-28 Wet Cycle Plots: Torque vs. Load
Section 7	¼-28 Friction Coefficients
Section 8	¼-28 Test Plate Layouts
Section 9	¼-28 Dry Run Logs
Section 10	¼-28 Wet Run Logs

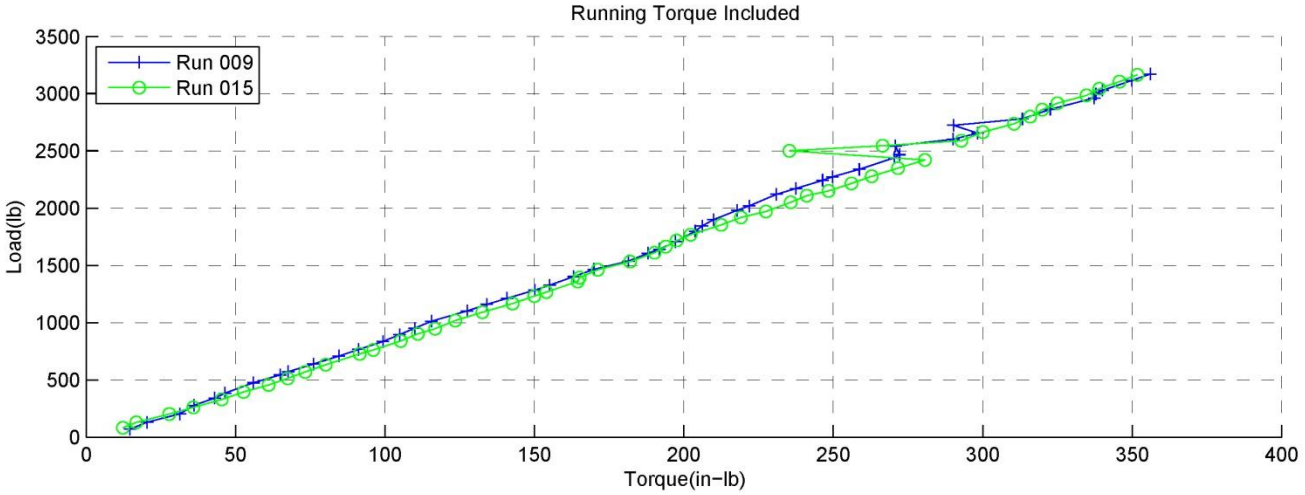

Torque vs. Load: Cycle No. 1
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : No Lube : Insert = ExHD − MS51832CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 007
Run 013
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300

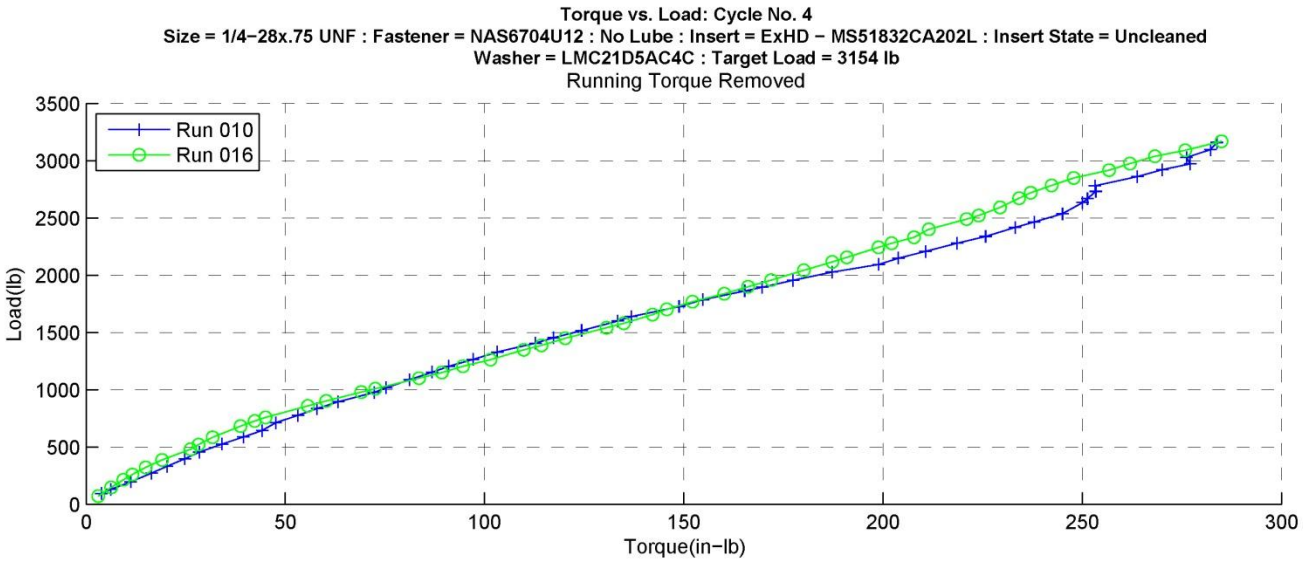

Running Torque Included
Run 007
Run 013
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300
350

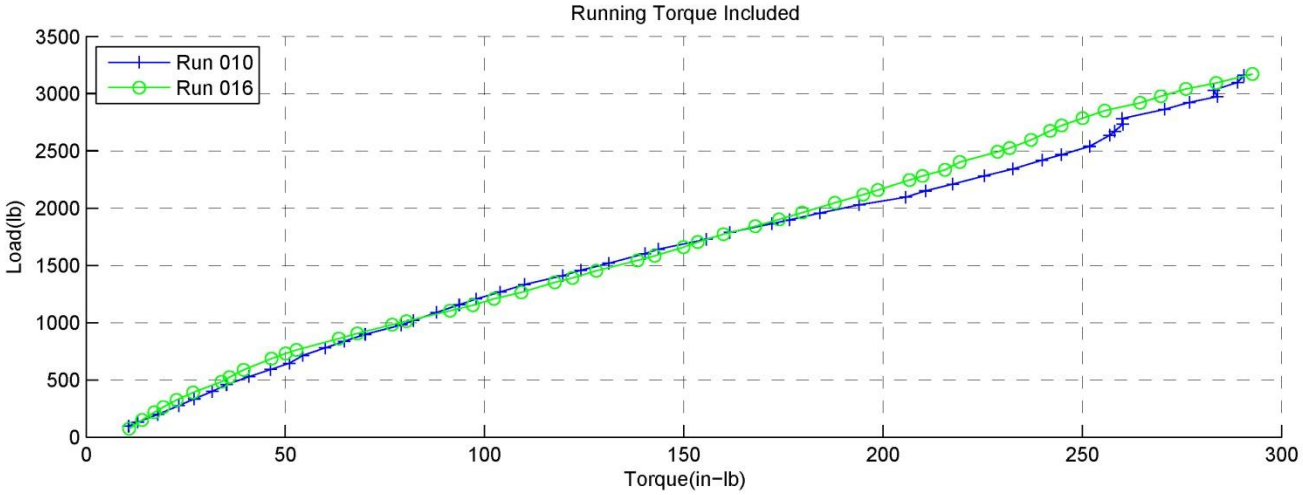

Torque vs. Load: Cycle No. 2
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : No Lube : Insert = ExHD − MS51832CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 008
Run 014
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300
350

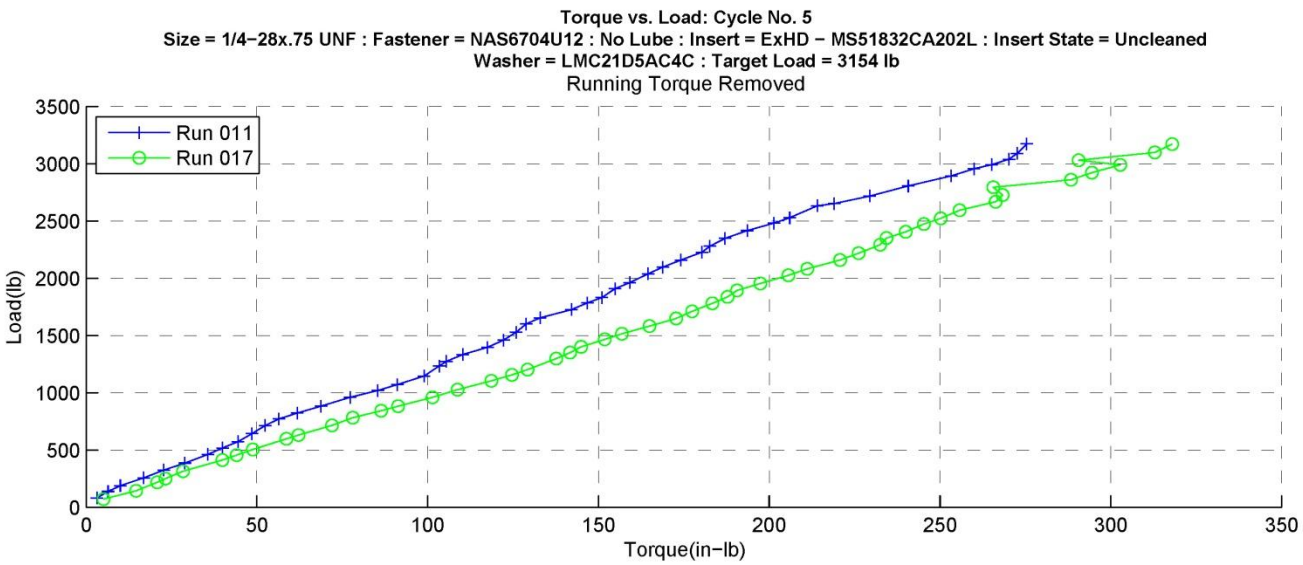

Running Torque Included
Run 008
Run 014
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300
350

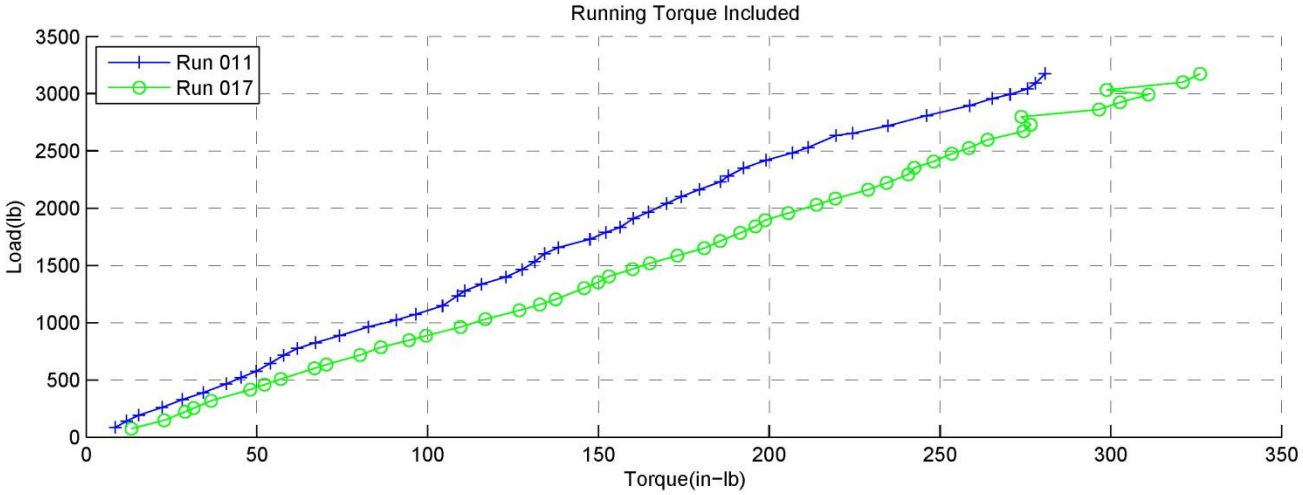

Torque vs. Load: Cycle No. 3
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : No Lube : Insert = ExHD − MS51832CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 009
Run 015
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300
350

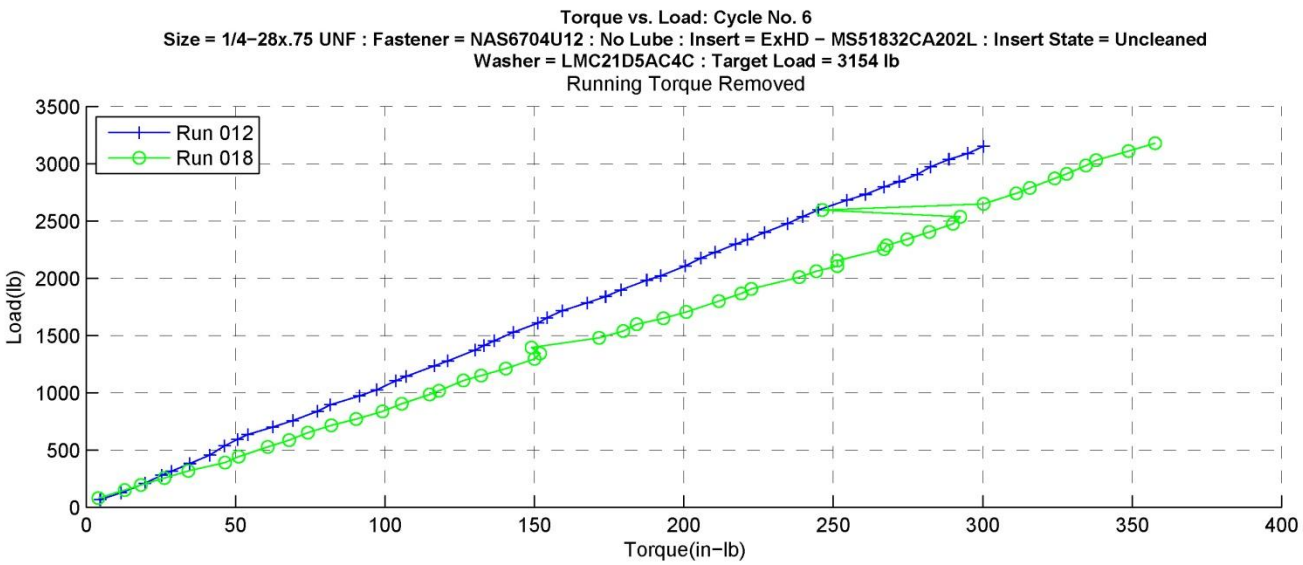

Running Torque Included
Run 009
Run 015
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300
350
400

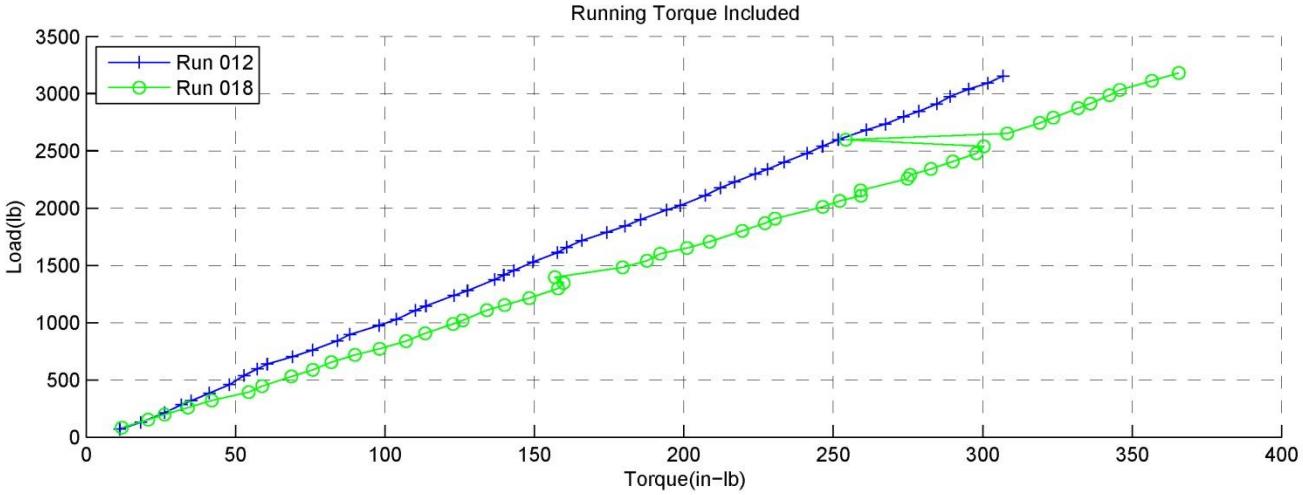

Torque vs. Load: Cycle No. 4
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : No Lube : Insert = ExHD − MS51832CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 010
Run 016
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300

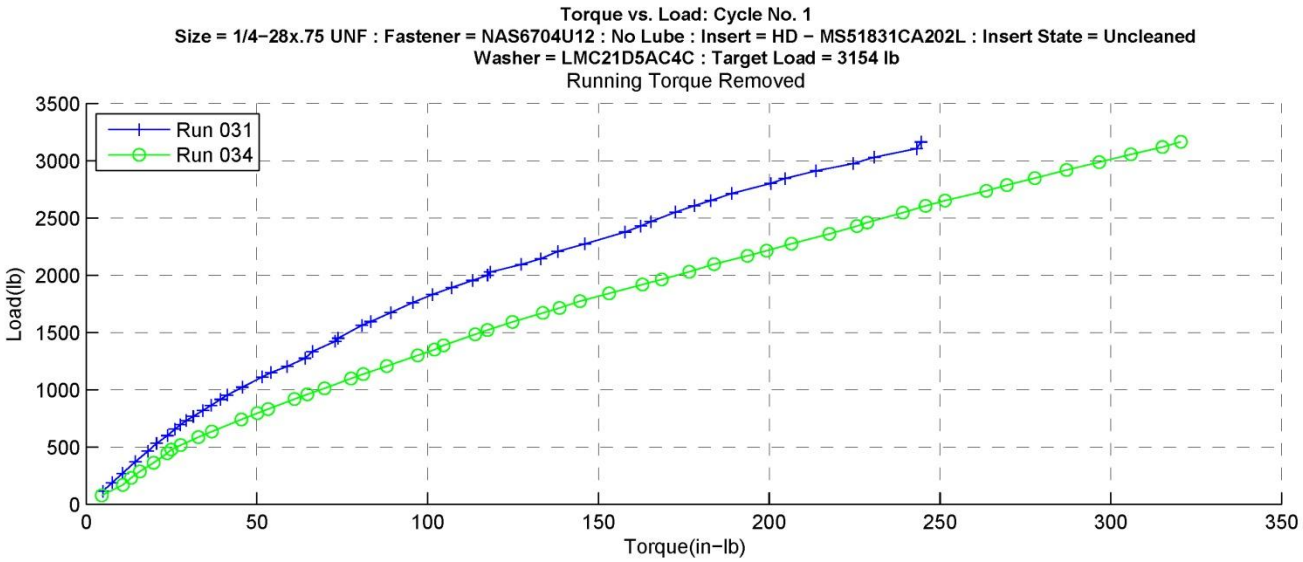

Running Torque Included
Run 010
Run 016
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300

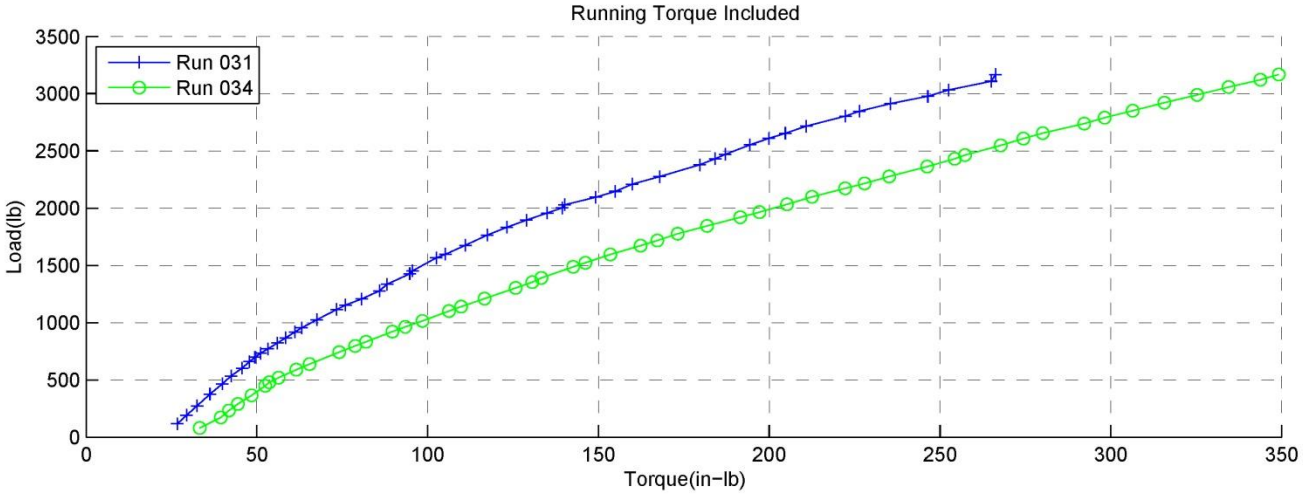

Torque vs. Load: Cycle No. 5
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : No Lube : Insert = ExHD − MS51832CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 011
Run 017
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300
350

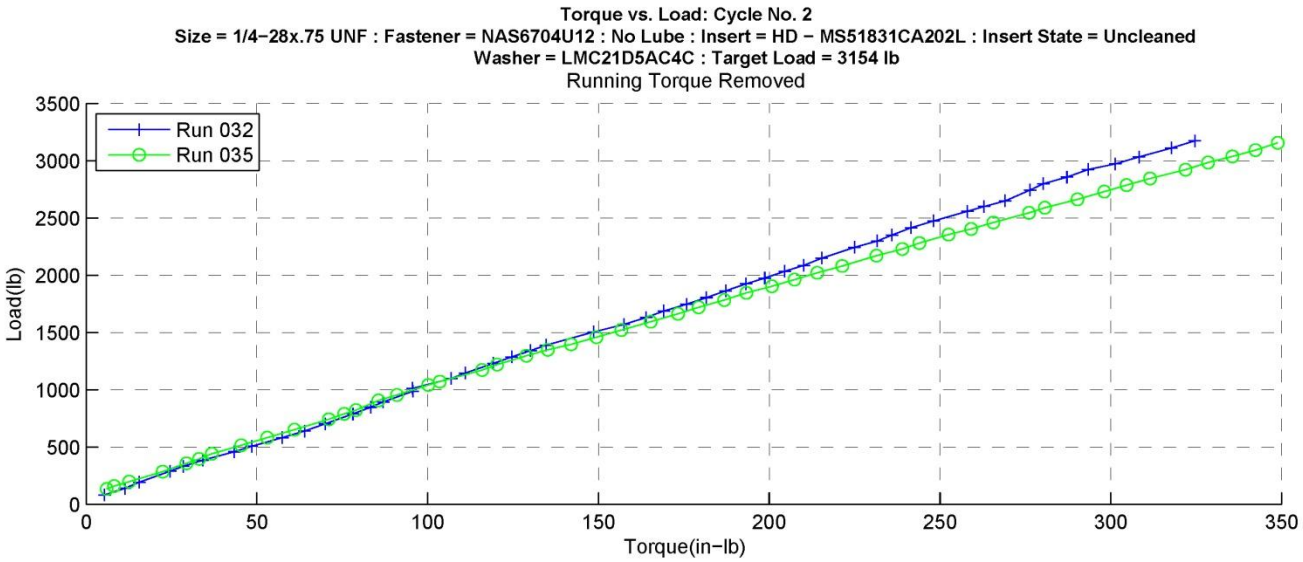

Running Torque Included
Run 011
Run 017
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300
350

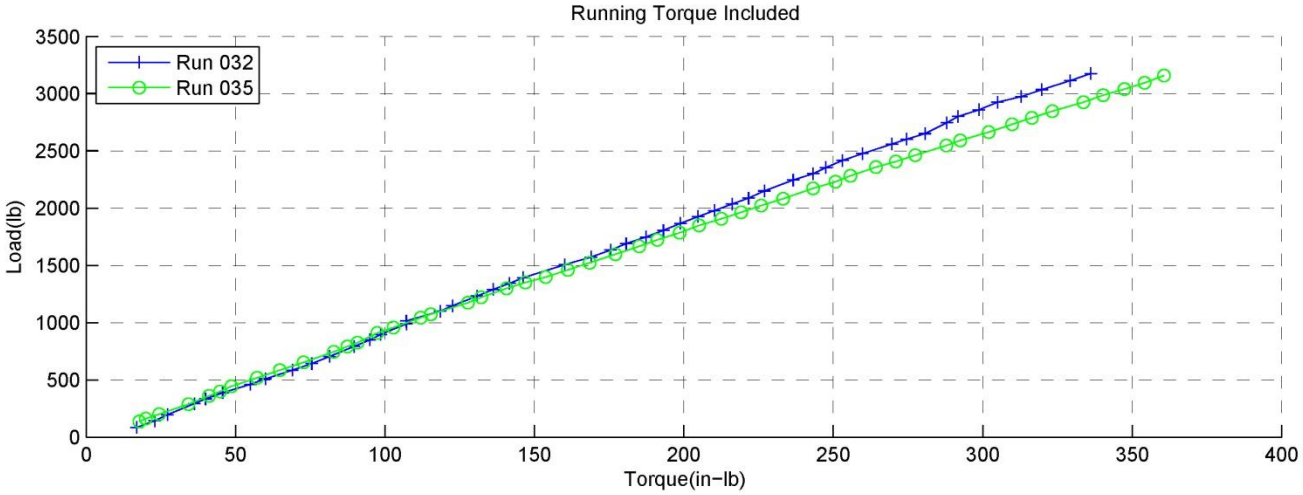

Torque vs. Load: Cycle No. 6
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : No Lube : Insert = ExHD − MS51832CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 012
Run 018
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300
350
400

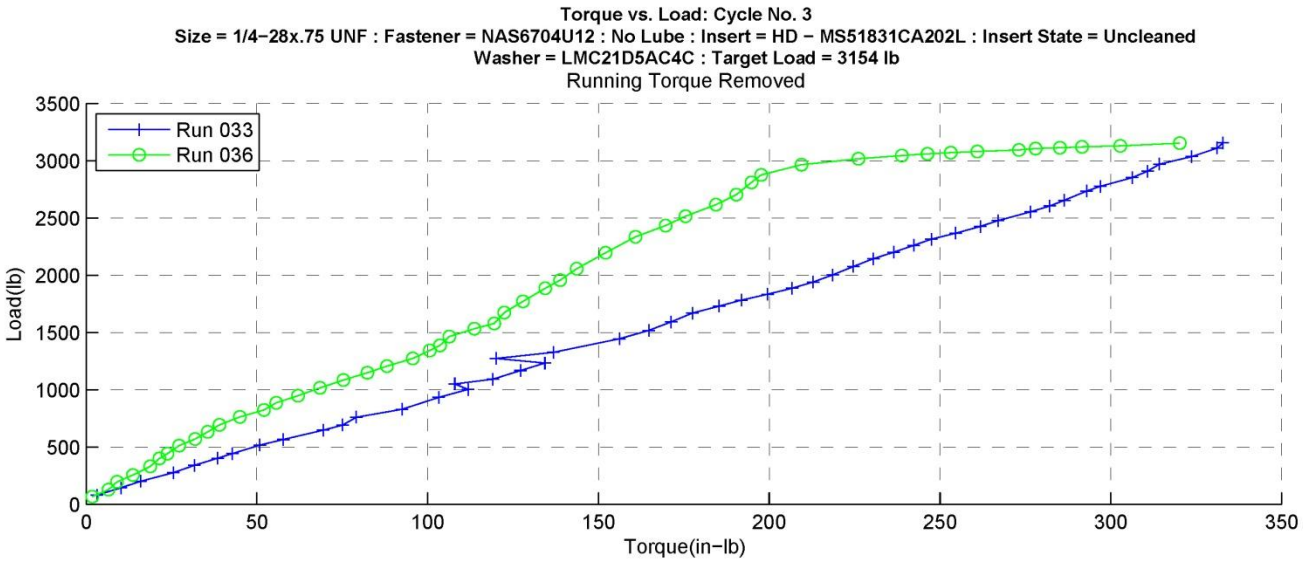

Running Torque Included
Run 012
Run 018
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300
350
400

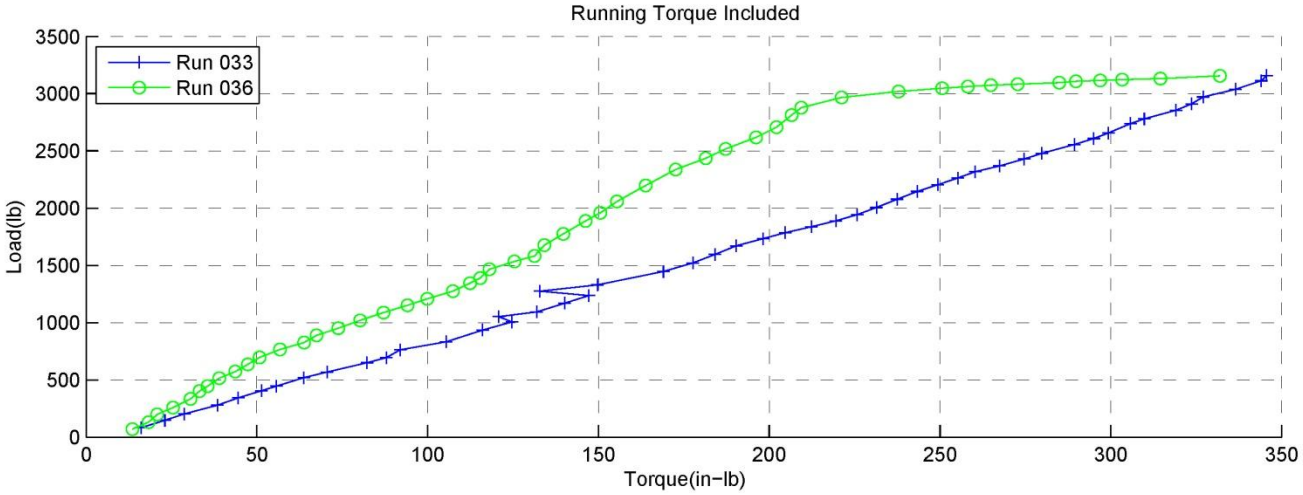

Torque vs. Load: Cycle No. 1
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : No Lube : Insert = HD − MS51831CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 031
Run 034
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300
350

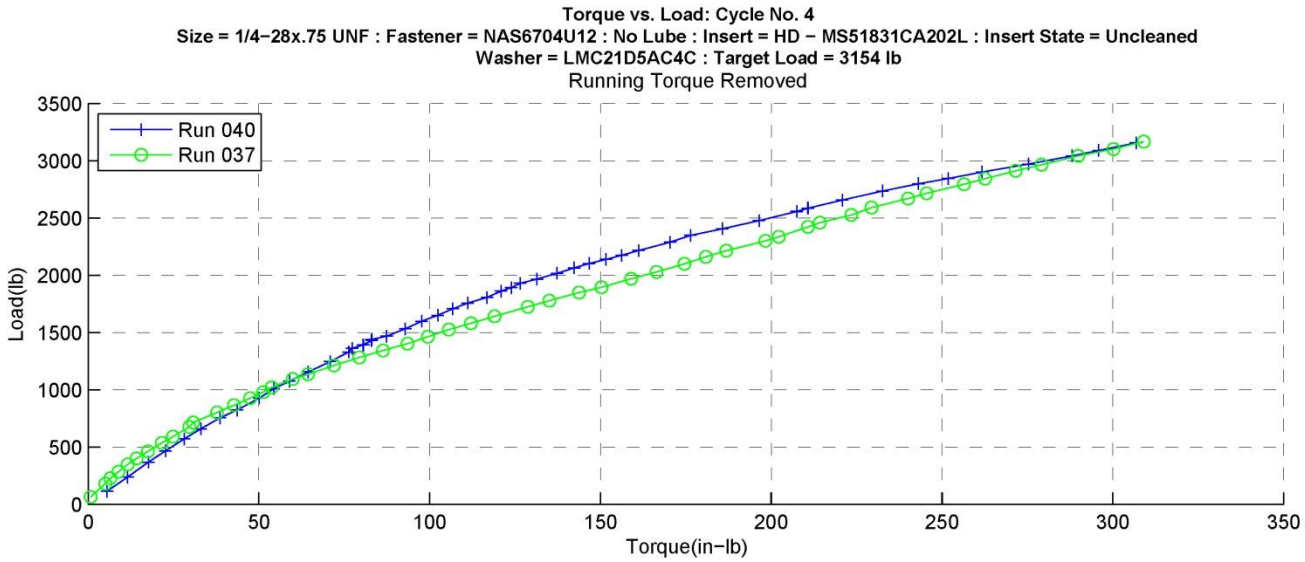

Running Torque Included
Run 031
Run 034
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300
350

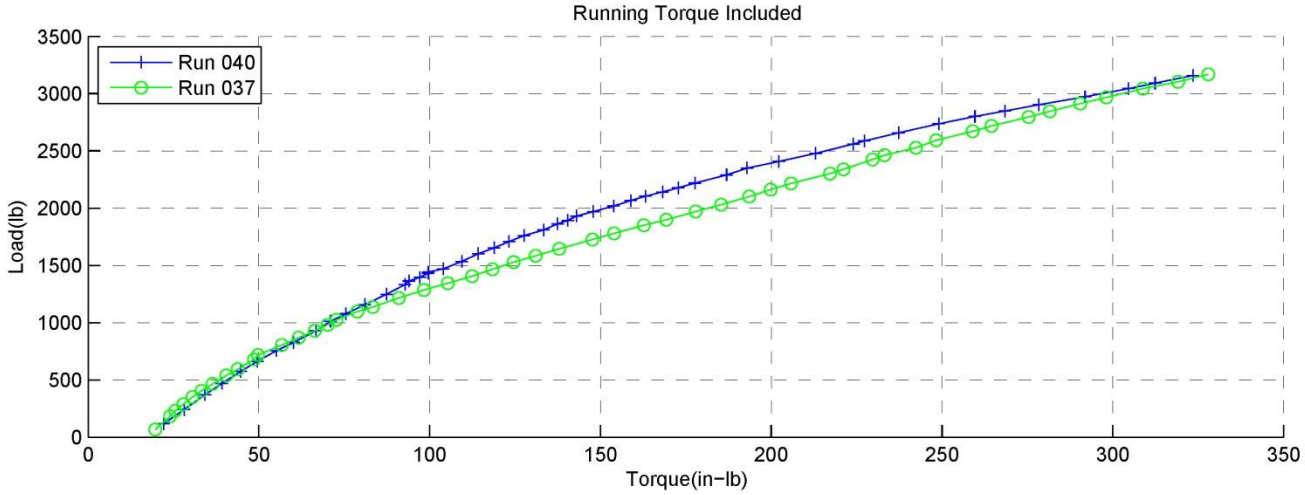

Torque vs. Load: Cycle No. 2
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : No Lube : Insert = HD − MS51831CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 032
Run 035
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300
350

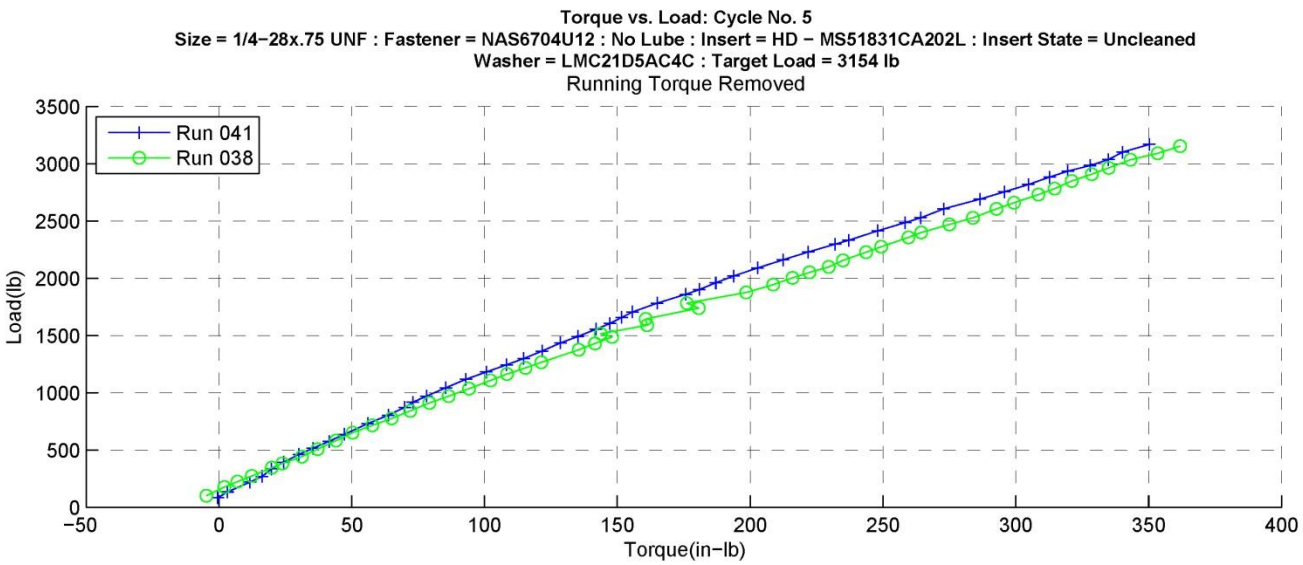

Running Torque Included
Run 032
Run 035
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300
350
400

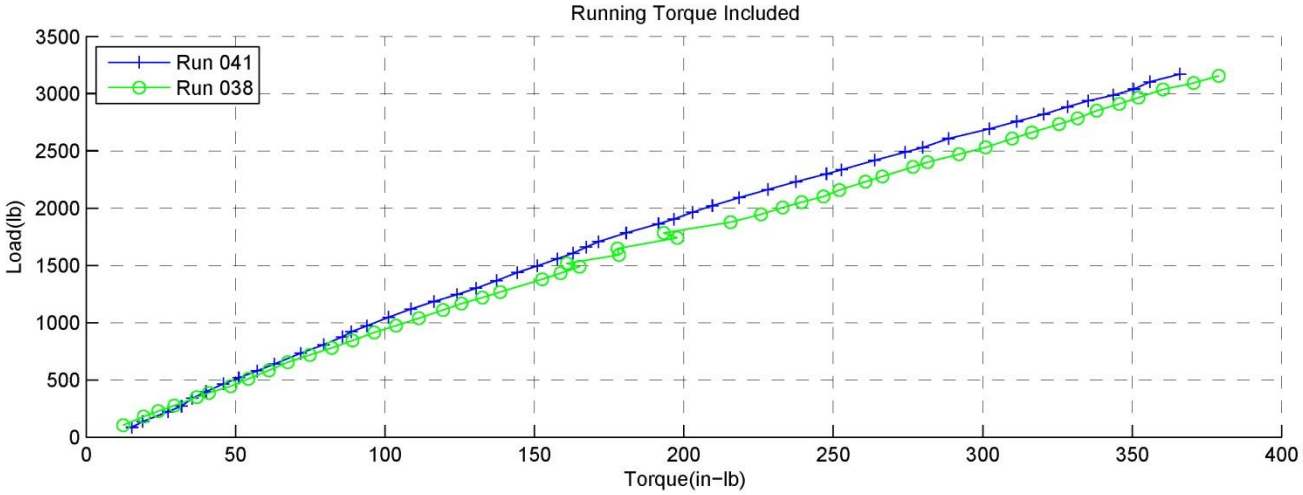

Torque vs. Load: Cycle No. 3
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : No Lube : Insert = HD − MS51831CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 033
Run 036
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300
350

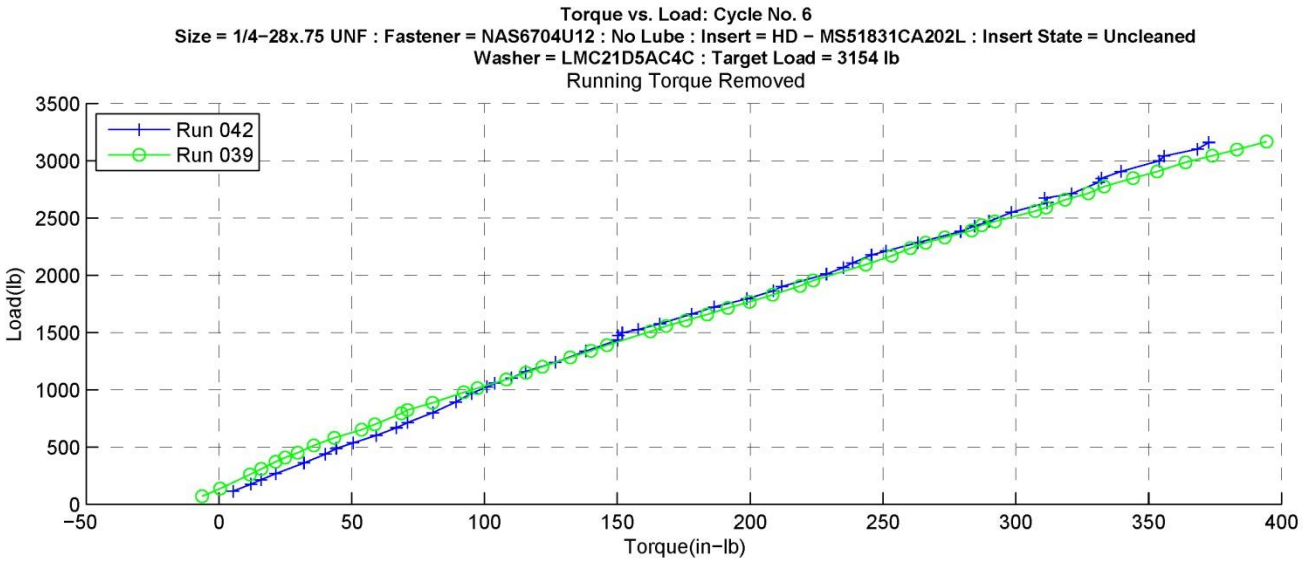

Running Torque Included
Run 033
Run 036
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300
350

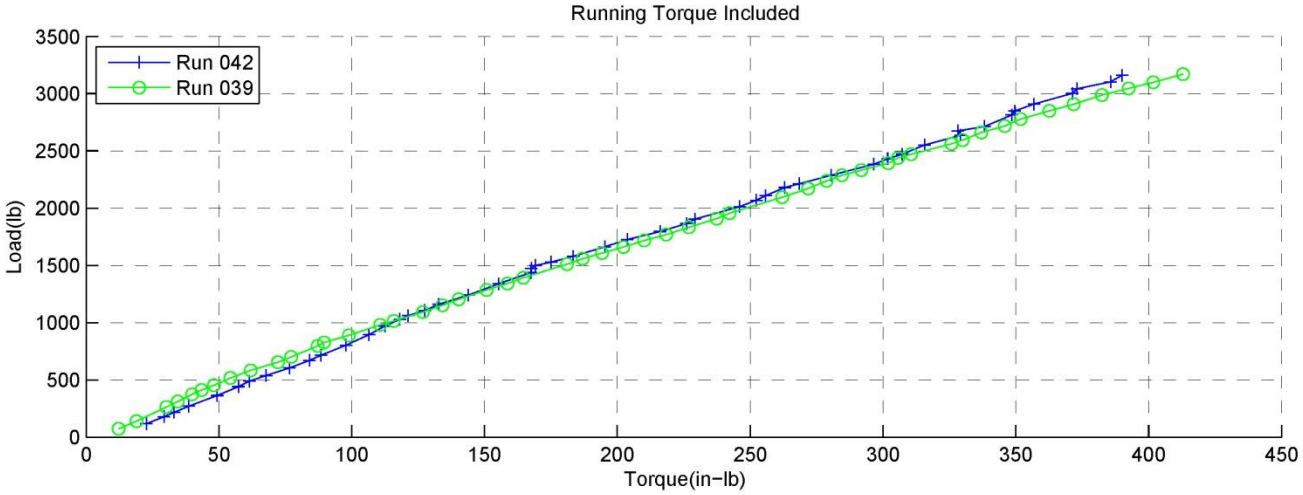

Torque vs. Load: Cycle No. 4
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : No Lube : Insert = HD − MS51831CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 040
Run 037
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300
350

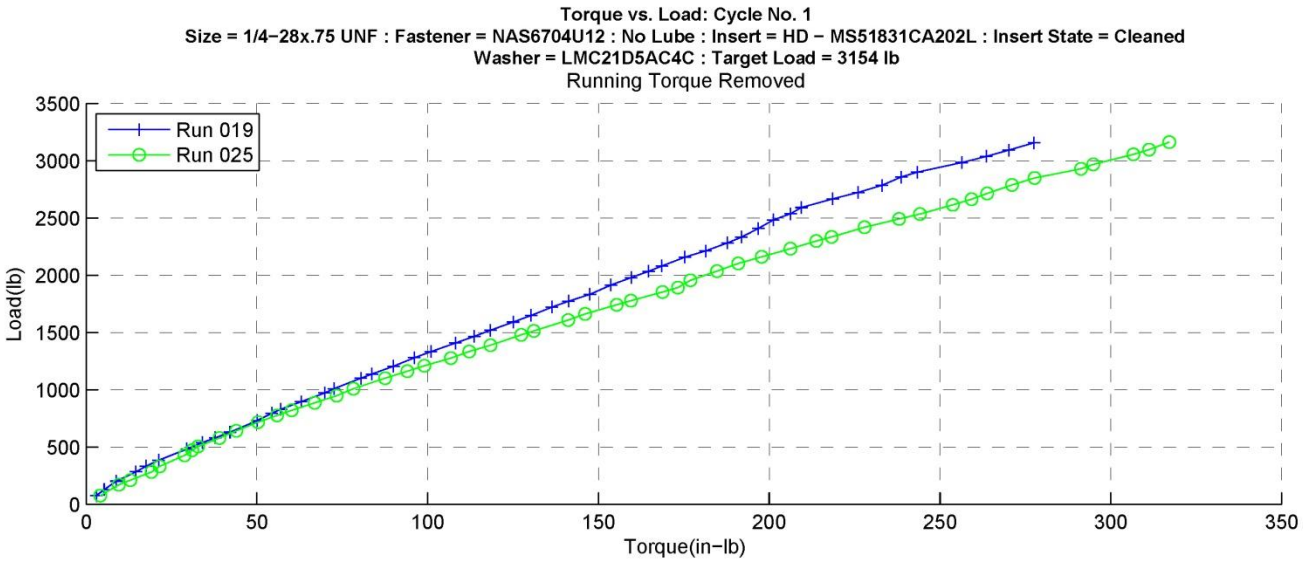

Running Torque Included
Run 040
Run 037
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300
350

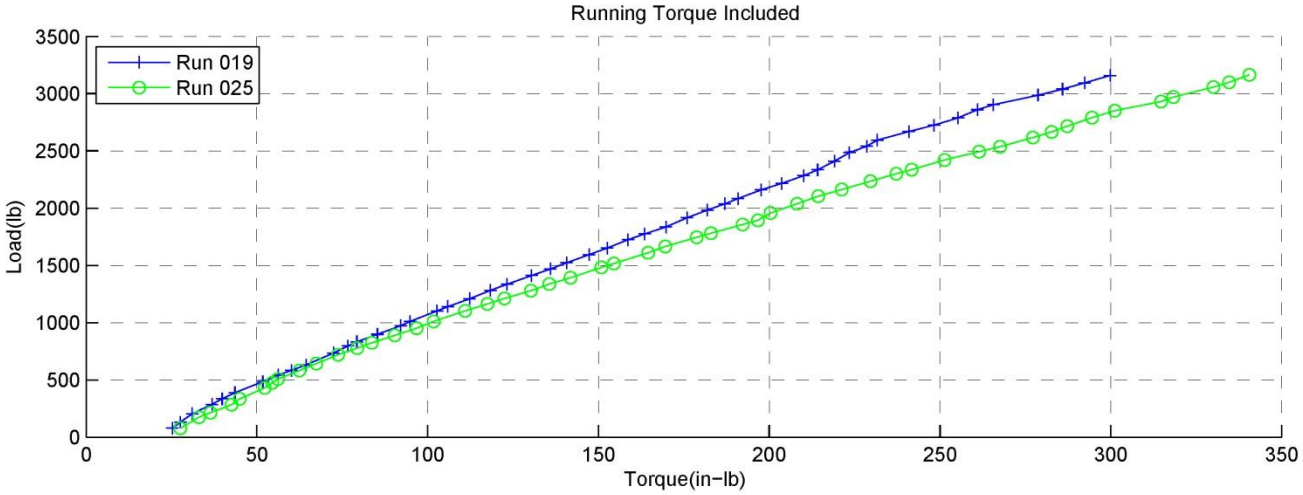

Torque vs. Load: Cycle No. 5
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : No Lube : Insert = HD − MS51831CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 041
Run 038
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
−50
0
50
100
150
200
250
300
350
400

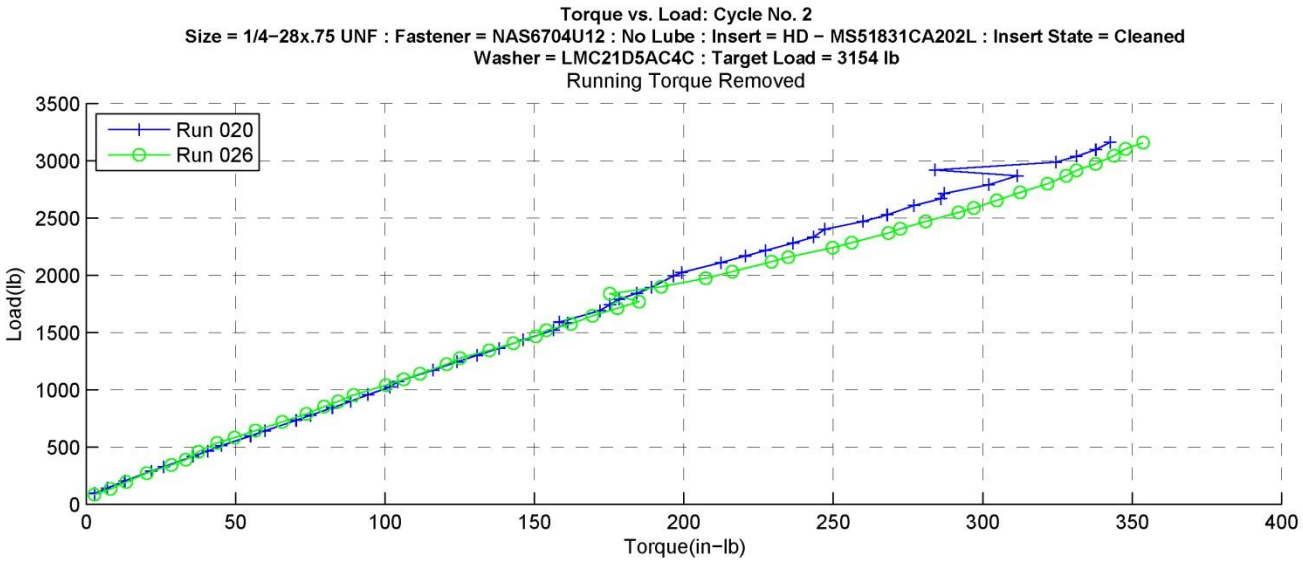

Running Torque Included
Run 041
Run 038
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
0
50
100
150
200
250
300
350
400

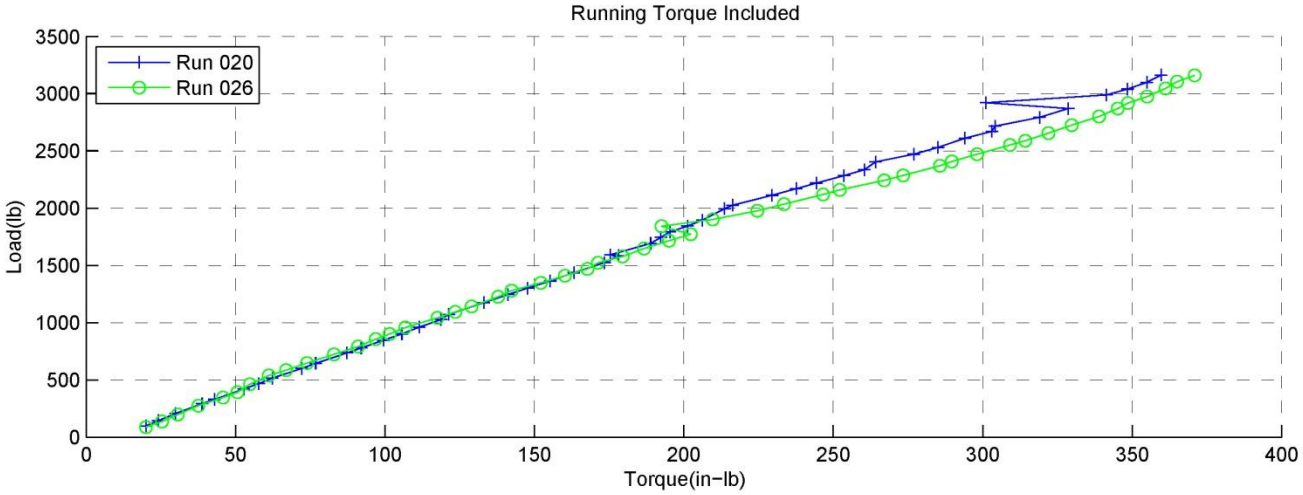

Torque vs. Load: Cycle No. 6
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : No Lube : Insert = HD − MS51831CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 042
Run 039
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
−50
0
50
100
150
200
250
300
350
400

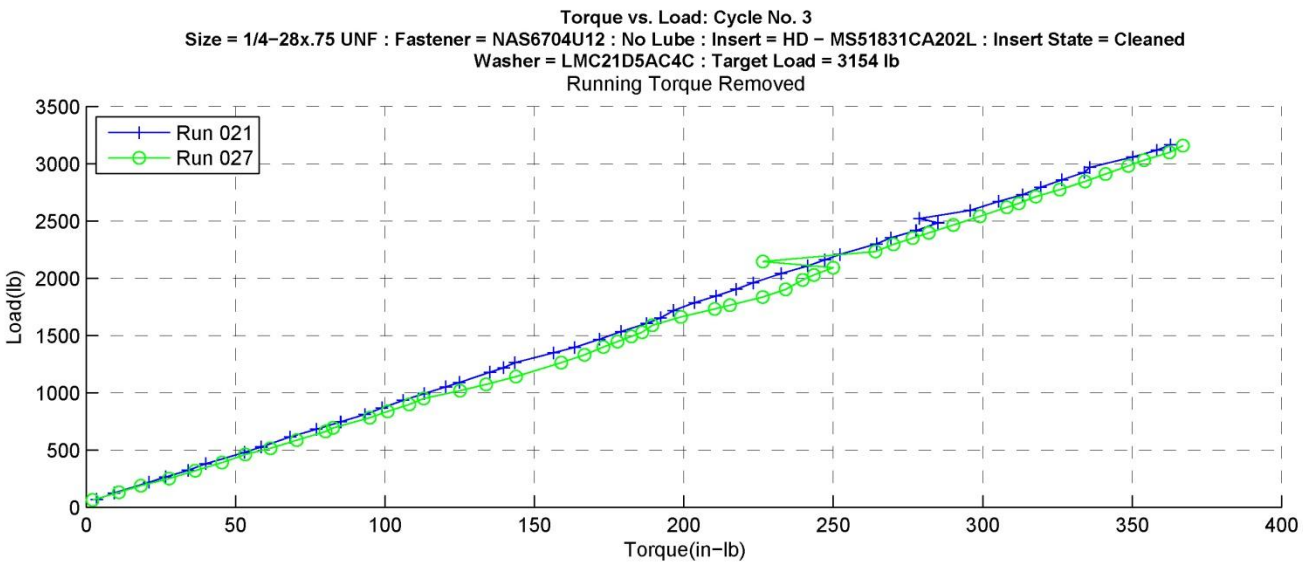

Running Torque Included
Run 042
Run 039
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
0
50
100
150
200
250
300
350
400
450

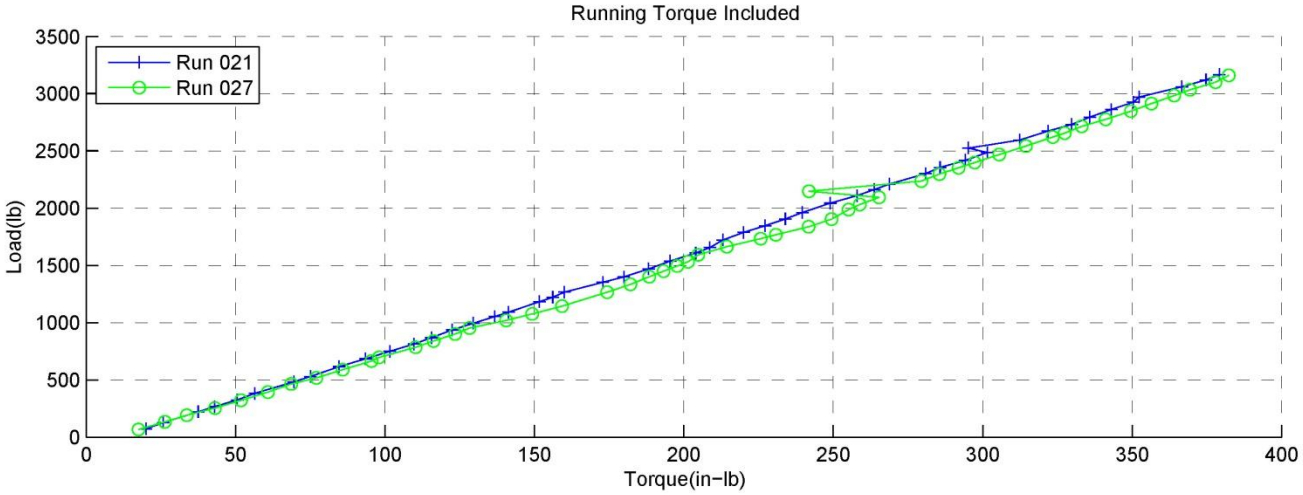

Torque vs. Load: Cycle No. 1
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : No Lube : Insert = HD − MS51831CA202L : Insert State = Cleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 019
Run 025
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300
350

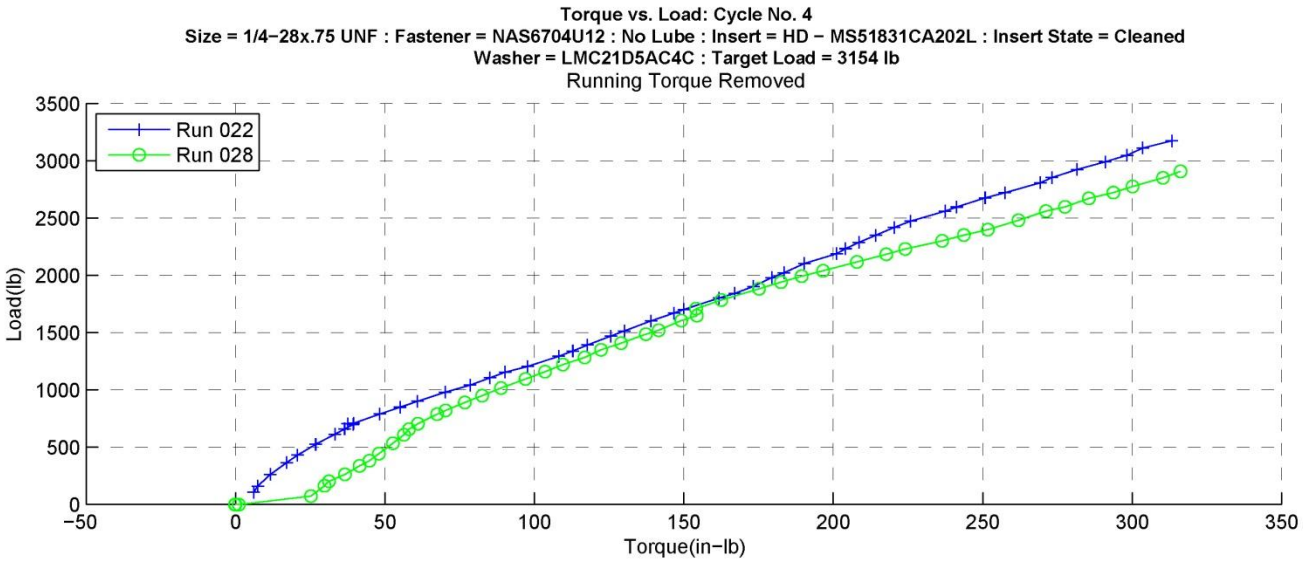

Running Torque Included
Run 019
Run 025
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300
350

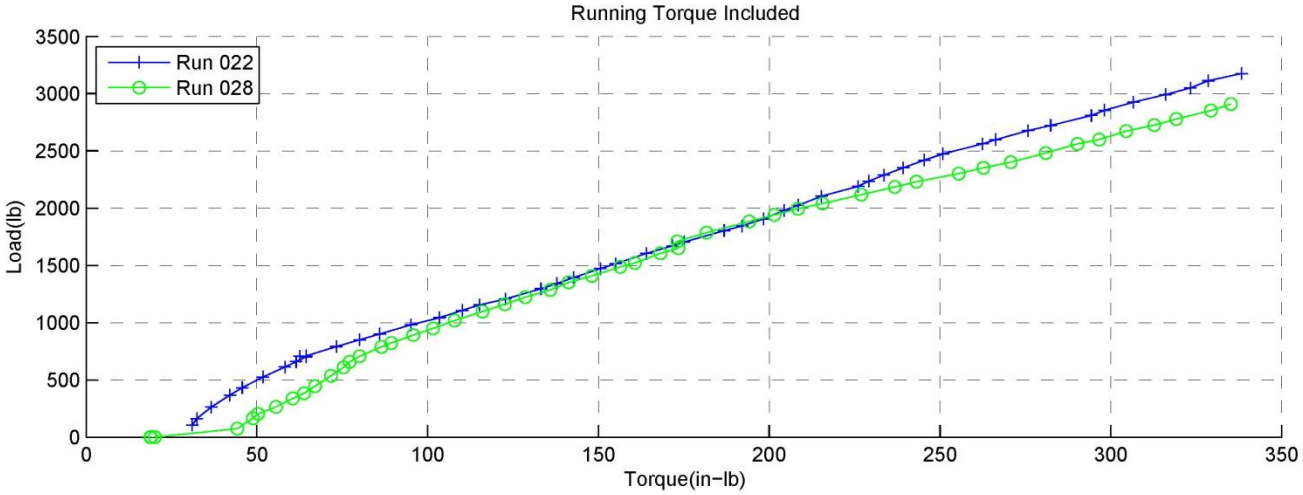

Torque vs. Load: Cycle No. 2
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : No Lube : Insert = HD − MS51831CA202L : Insert State = Cleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 020
Run 026
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300
350
400

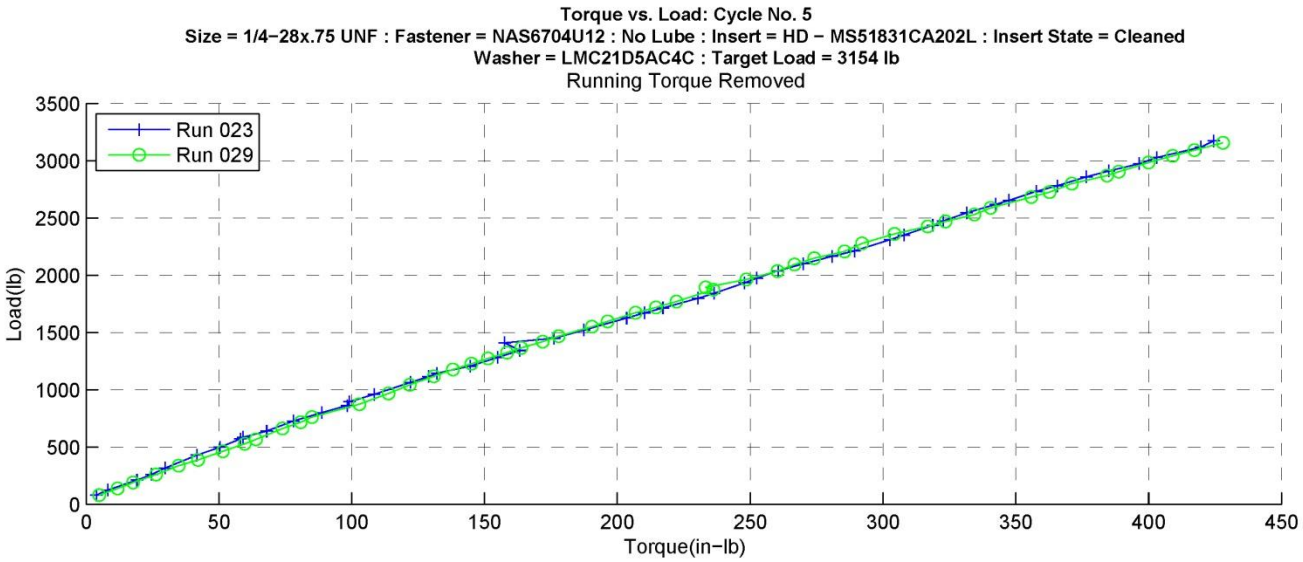

Running Torque Included
Run 020
Run 026
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300
350
400

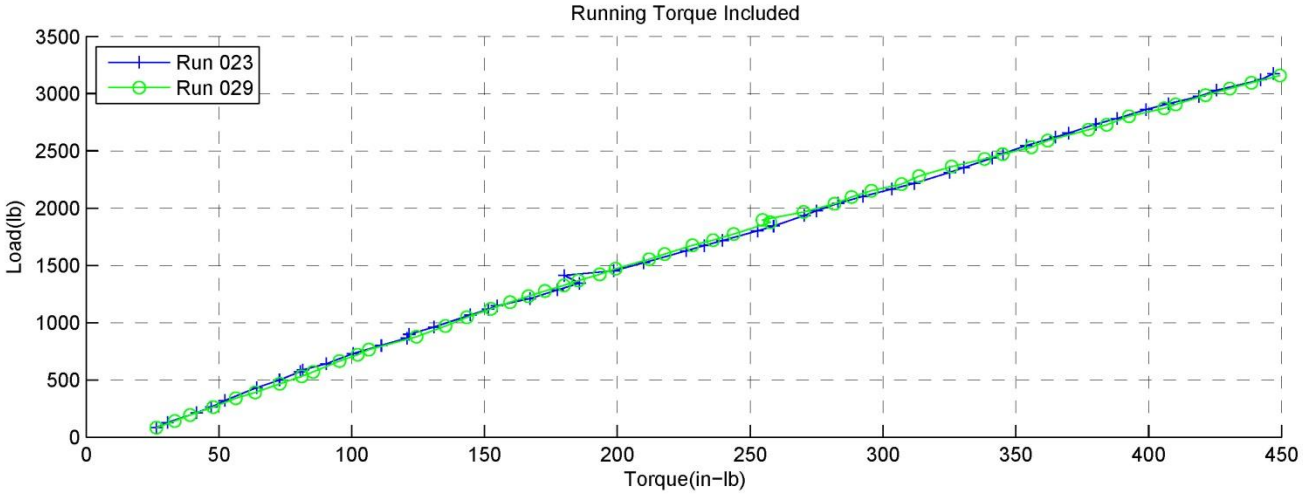

Torque vs. Load: Cycle No. 3
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : No Lube : Insert = HD − MS51831CA202L : Insert State = Cleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 021
Run 027
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300
350
400

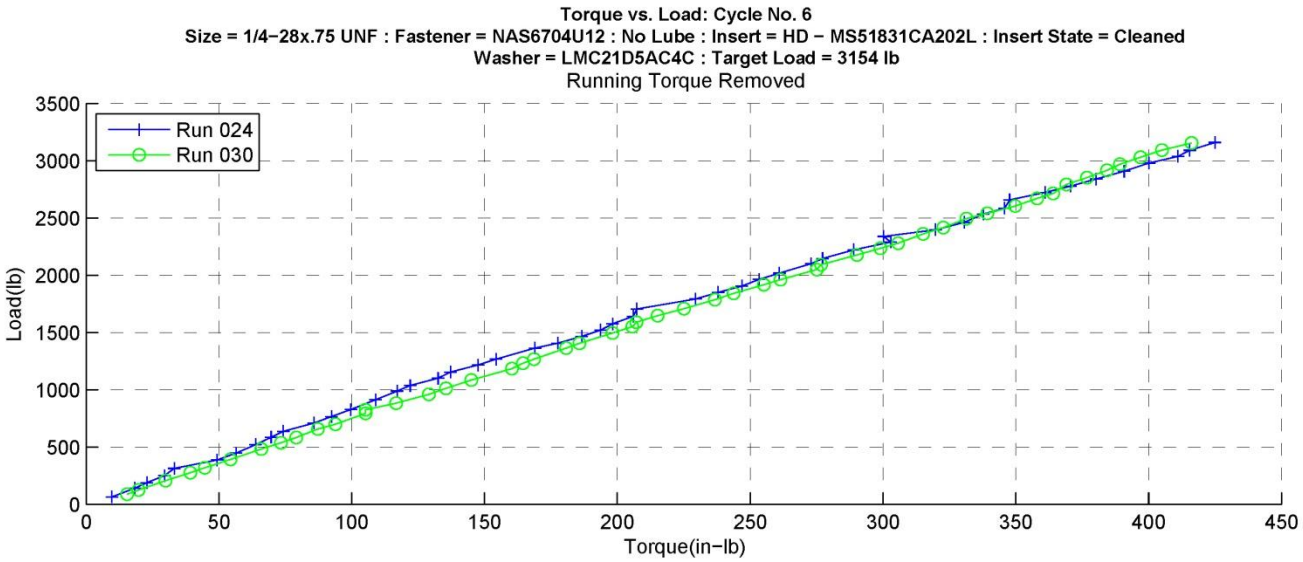

Running Torque Included
Run 021
Run 027
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300
350
400

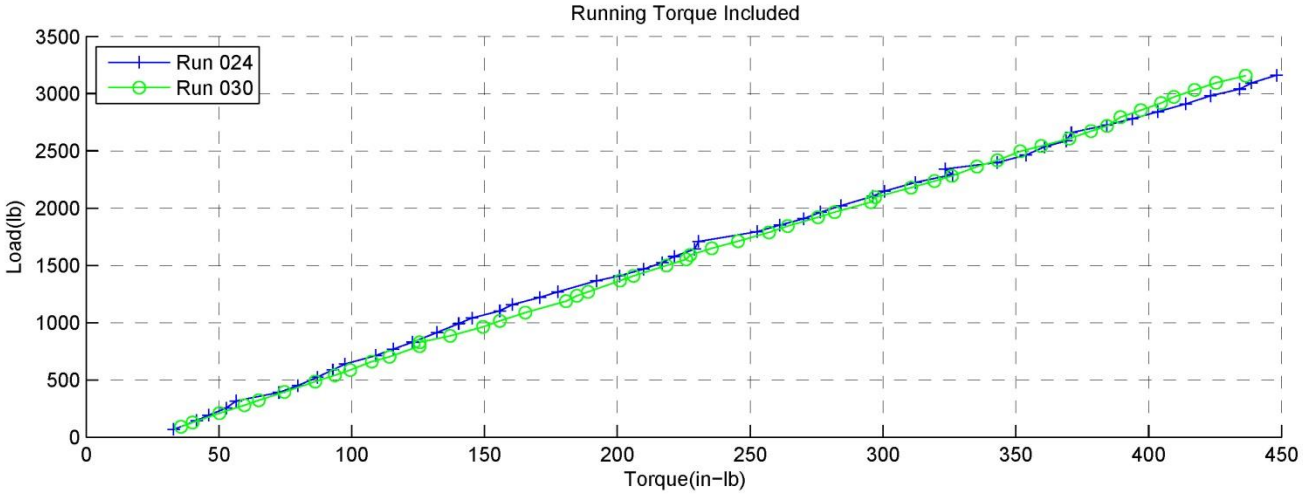

Torque vs. Load: Cycle No. 4
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : No Lube : Insert = HD − MS51831CA202L : Insert State = Cleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 022
Run 028
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
−50
0
50
100
150
200
250
300
350


Running Torque Included
Run 022
Run 028
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
0
50
100
150
200
250
300
350


Torque vs. Load: Cycle No. 5
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : No Lube : Insert = HD − MS51831CA202L : Insert State = Cleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 023
Run 029
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300
350
400
450

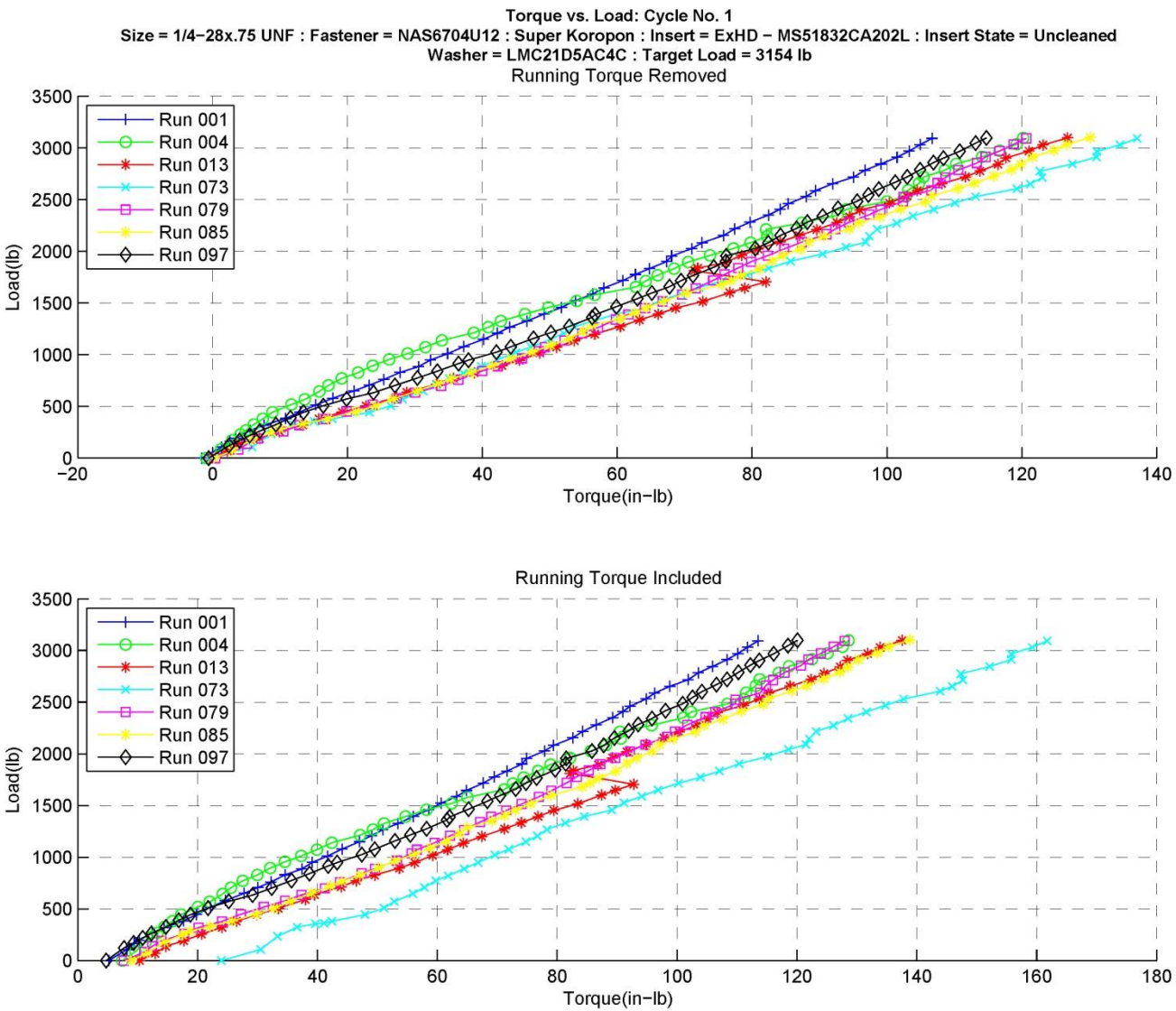

Running Torque Included
Run 023
Run 029
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300
350
400
450

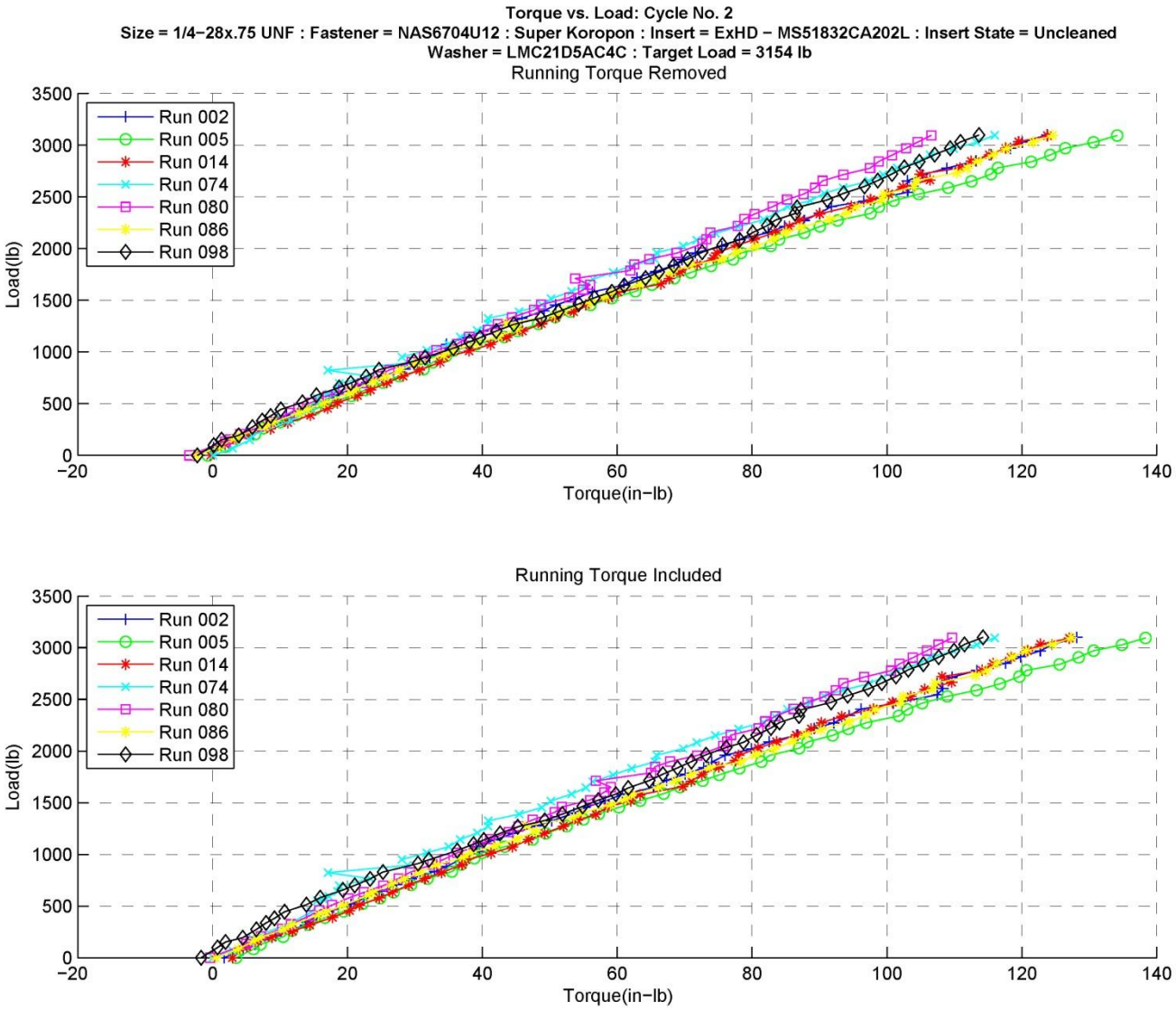

Torque vs. Load: Cycle No. 6
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : No Lube : Insert = HD − MS51831CA202L : Insert State = Cleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 024
Run 030
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300
350
400
450

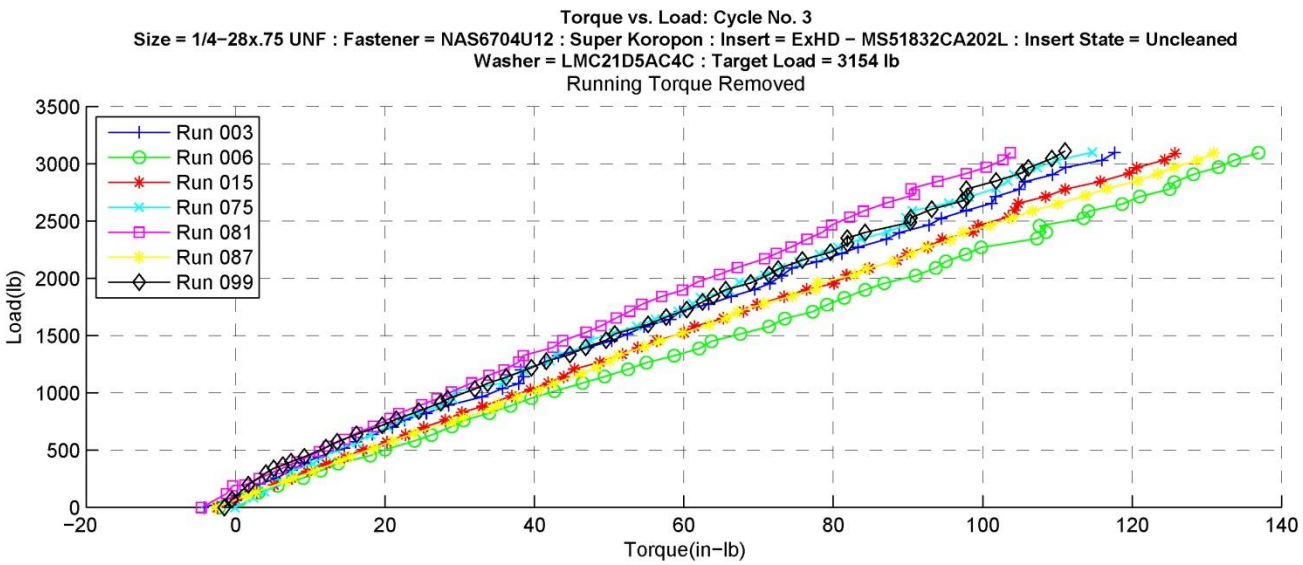

Running Torque Included
Run 024
Run 030
Load(lb)
Torque(in−lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150
200
250
300
350
400
450

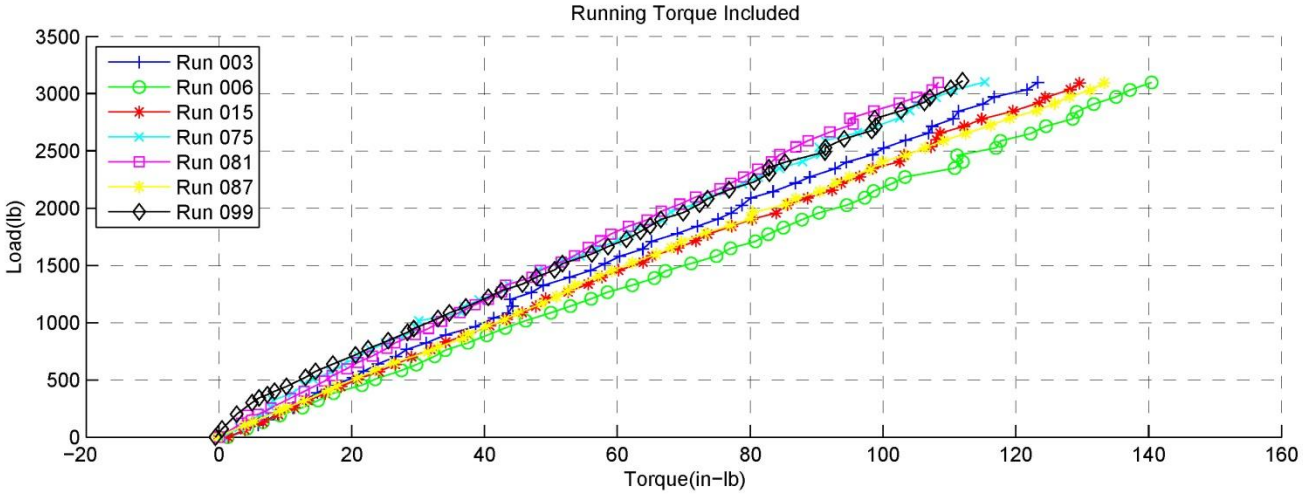
Appendix B:

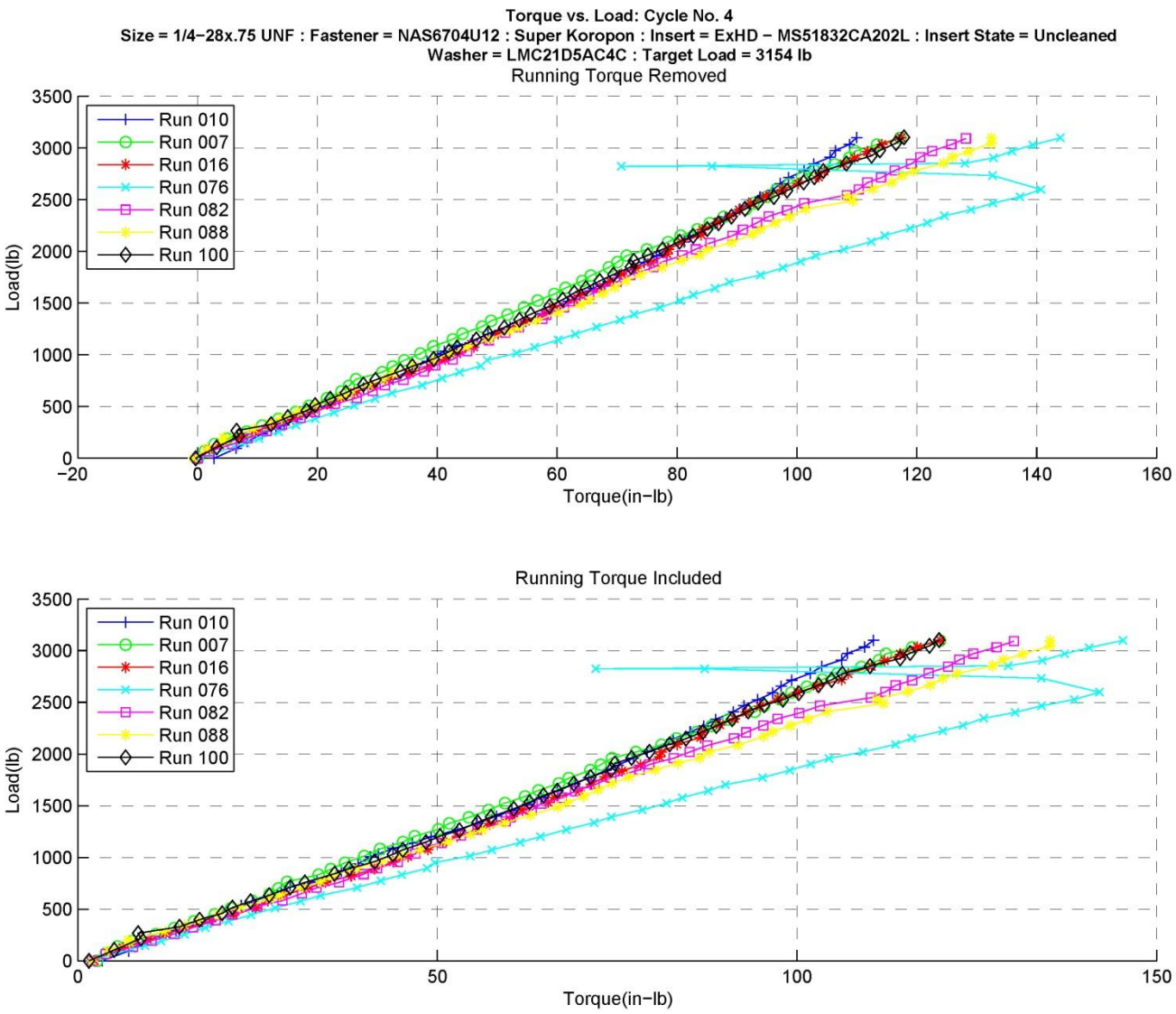
Section 1	¼-28 Dry Torque Tension Plots
Section 2	¼-28 Wet Torque Tension Plots
Section 3	¼-28 Dry Running Torque Plots
Section 4	¼-28 Wet Running Torque Plots
Section 5	¼-28 Dry Cycle Plots: Torque vs. Load
Section 6	¼-28 Wet Cycle Plots: Torque vs. Load
Section 7	¼-28 Friction Coefficients
Section 8	¼-28 Test Plate Layouts
Section 9	¼-28 Dry Run Logs
Section 10	¼-28 Wet Run Logs

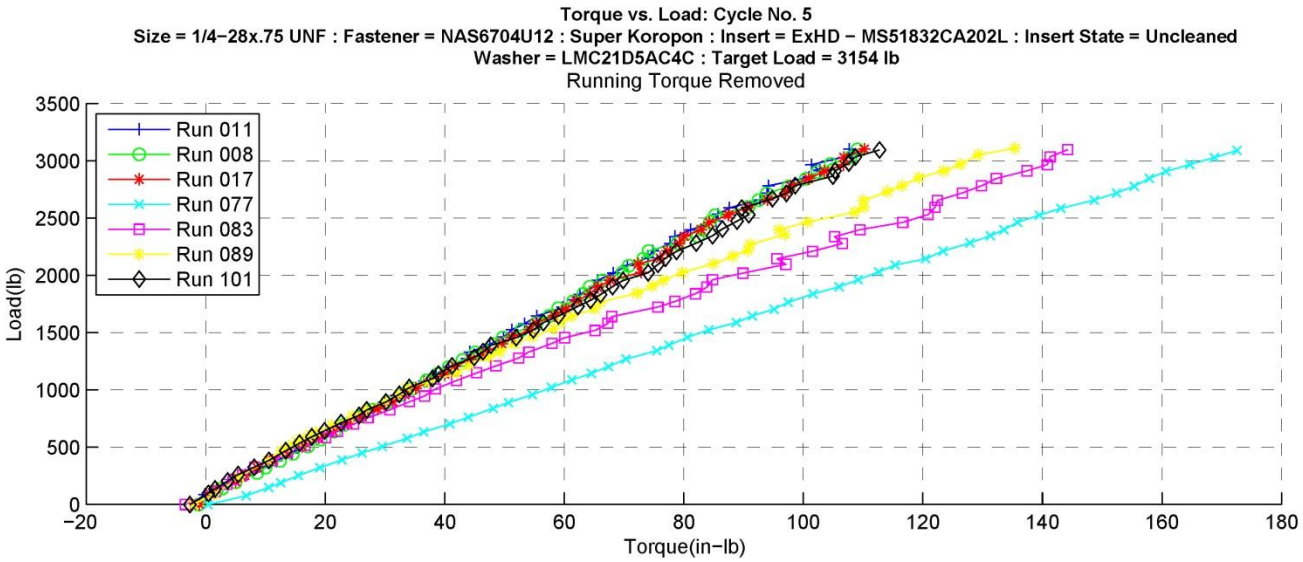

Torque vs. Load: Cycle No. 1
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Super Koropon : Insert = ExHD − MS51832CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Load(lb)
Torque(in−lb)
Run 001
Run 004
Run 013
Run 073
Run 079
Run 085
Run 097
Running Torque Included
Load(lb)
Torque(in−lb)
Run 001
Run 004
Run 013
Run 073
Run 079
Run 085
Run 097

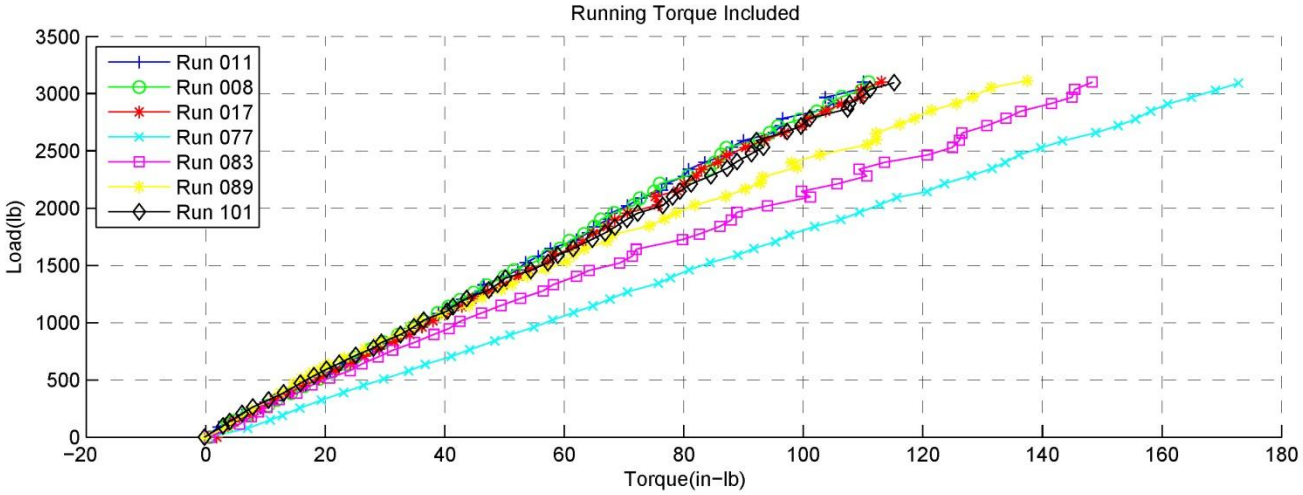

Torque vs. Load: Cycle No. 2
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Super Koropon : Insert = ExHD − MS51832CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 002
Run 005
Run 014
Run 074
Run 080
Run 086
Run 098
Load(lb)
Torque(in−lb)
Running Torque Included
Run 002
Run 005
Run 014
Run 074
Run 080
Run 086
Run 098
Load(lb)
Torque(in−lb)

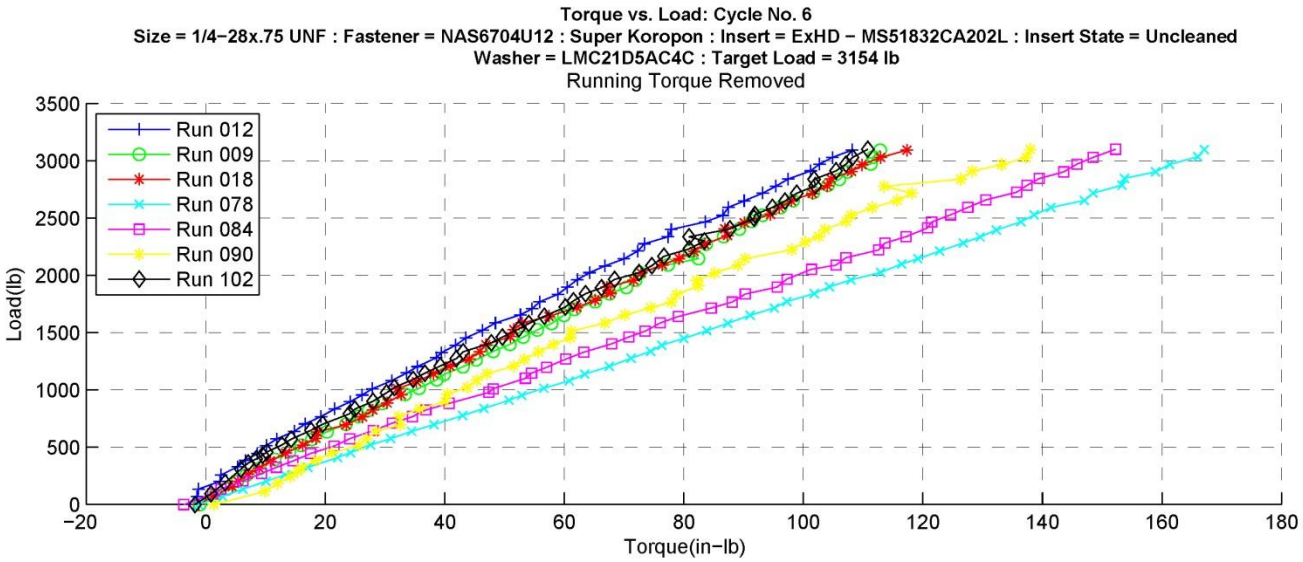

Torque vs. Load: Cycle No. 3
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Super Koropon : Insert = ExHD − MS51832CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 003
Run 006
Run 015
Run 075
Run 081
Run 087
Run 099
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
−20
0
20
40
60
80
100
120
140

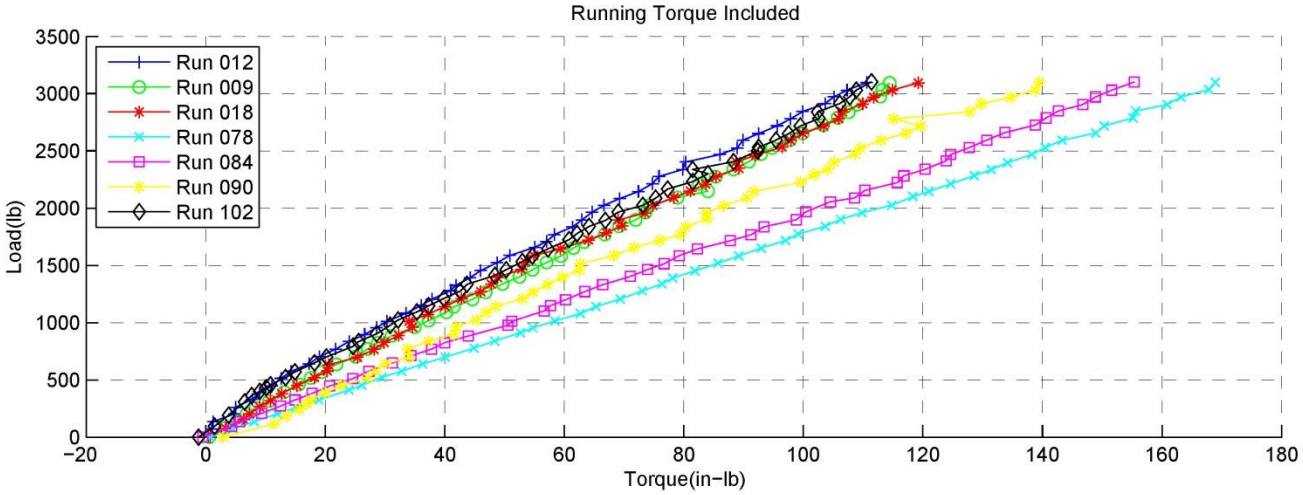

Running Torque Included
Run 003
Run 006
Run 015
Run 075
Run 081
Run 087
Run 099
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
−20
0
20
40
60
80
100
120
140
160

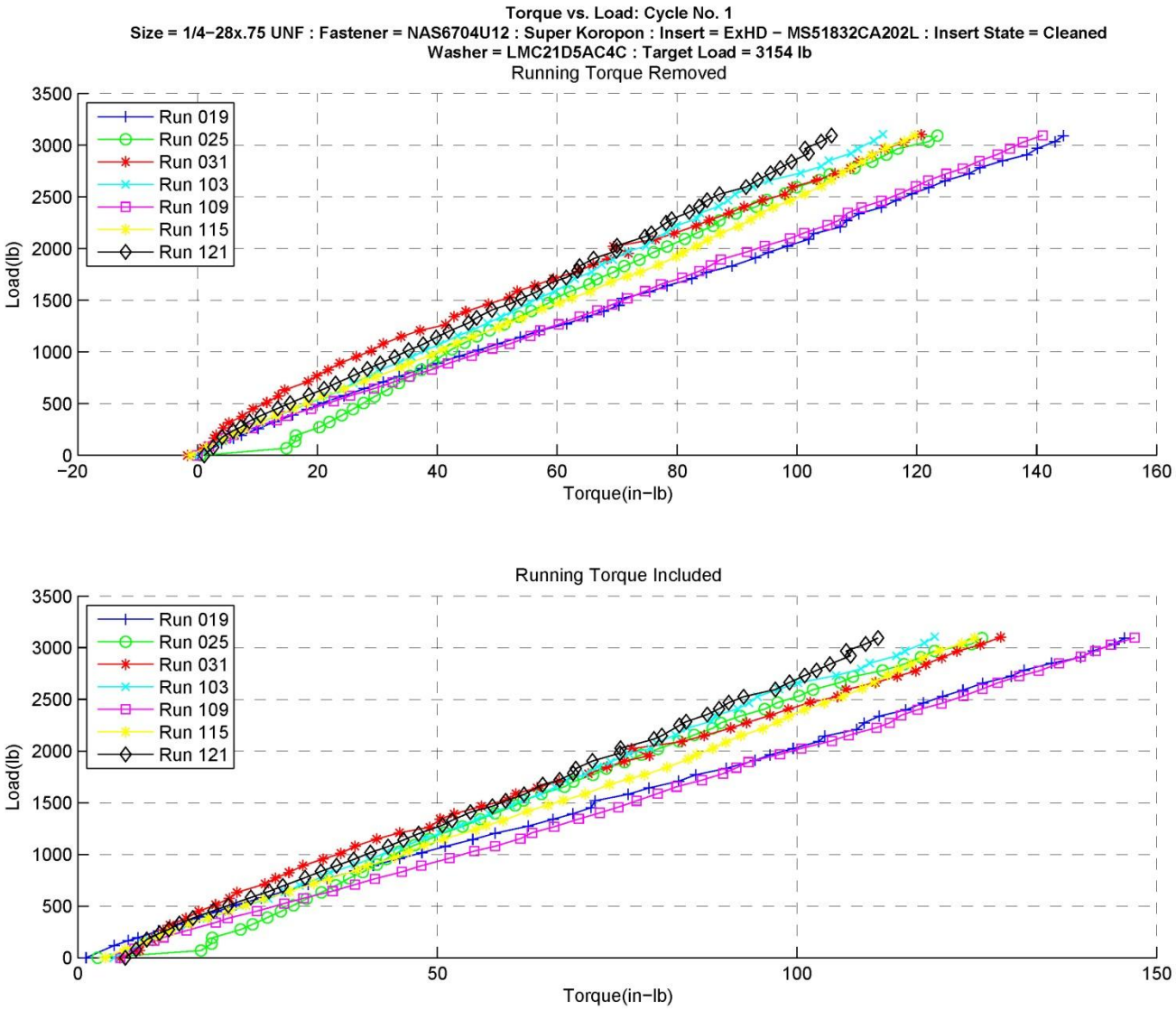

Torque vs. Load: Cycle No. 4
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Super Koropon : Insert = ExHD − MS51832CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Load(lb)
Torque(in−lb)
Run 010
Run 007
Run 016
Run 076
Run 082
Run 088
Run 100
Running Torque Included
Load(lb)
Torque(in−lb)
Run 010
Run 007
Run 016
Run 076
Run 082
Run 088
Run 100

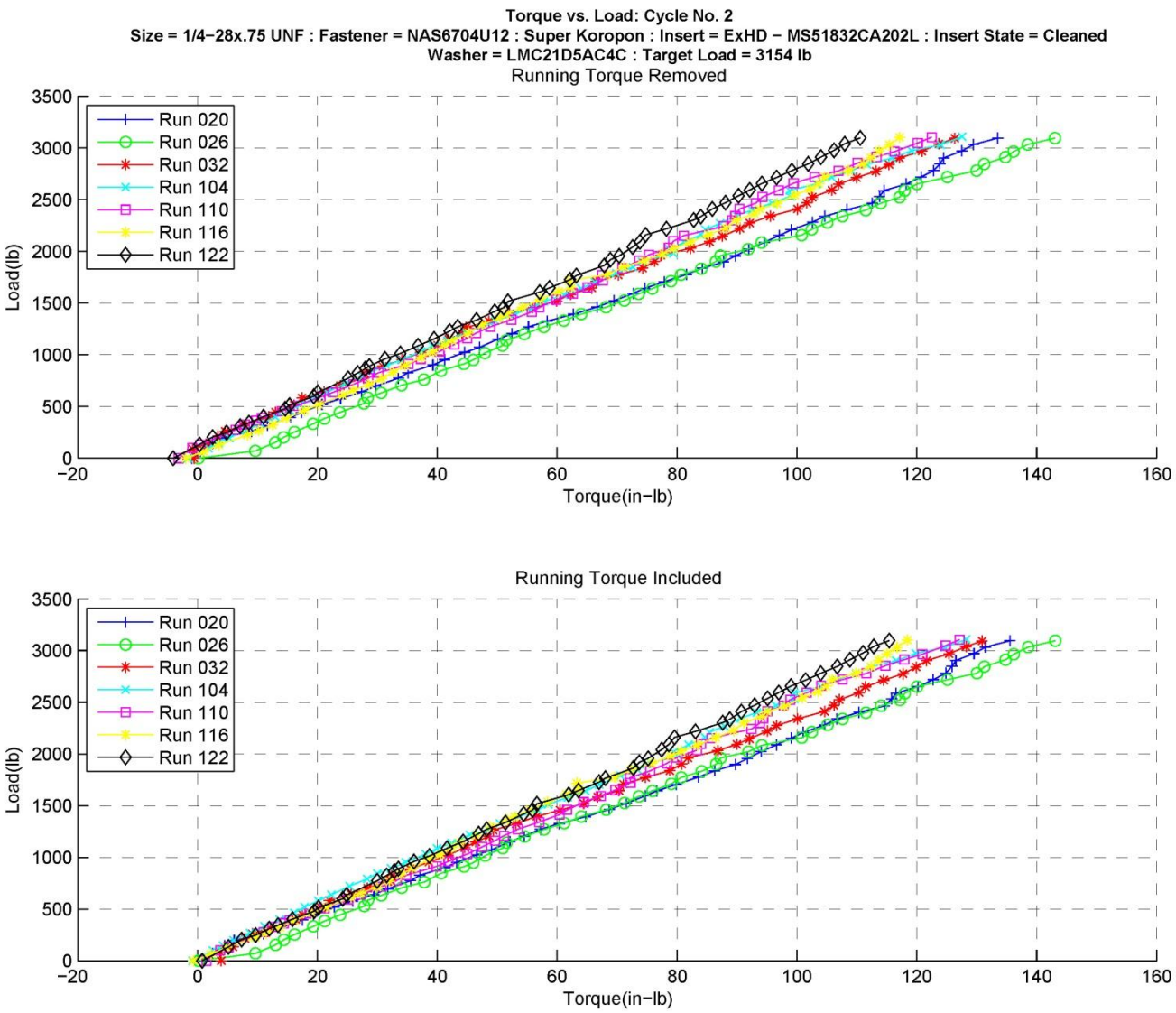

Torque vs. Load: Cycle No. 5
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Super Koropon : Insert = ExHD − MS51832CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 011
Run 008
Run 017
Run 077
Run 083
Run 089
Run 101
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
−20
0
20
40
60
80
100
120
140
160
180

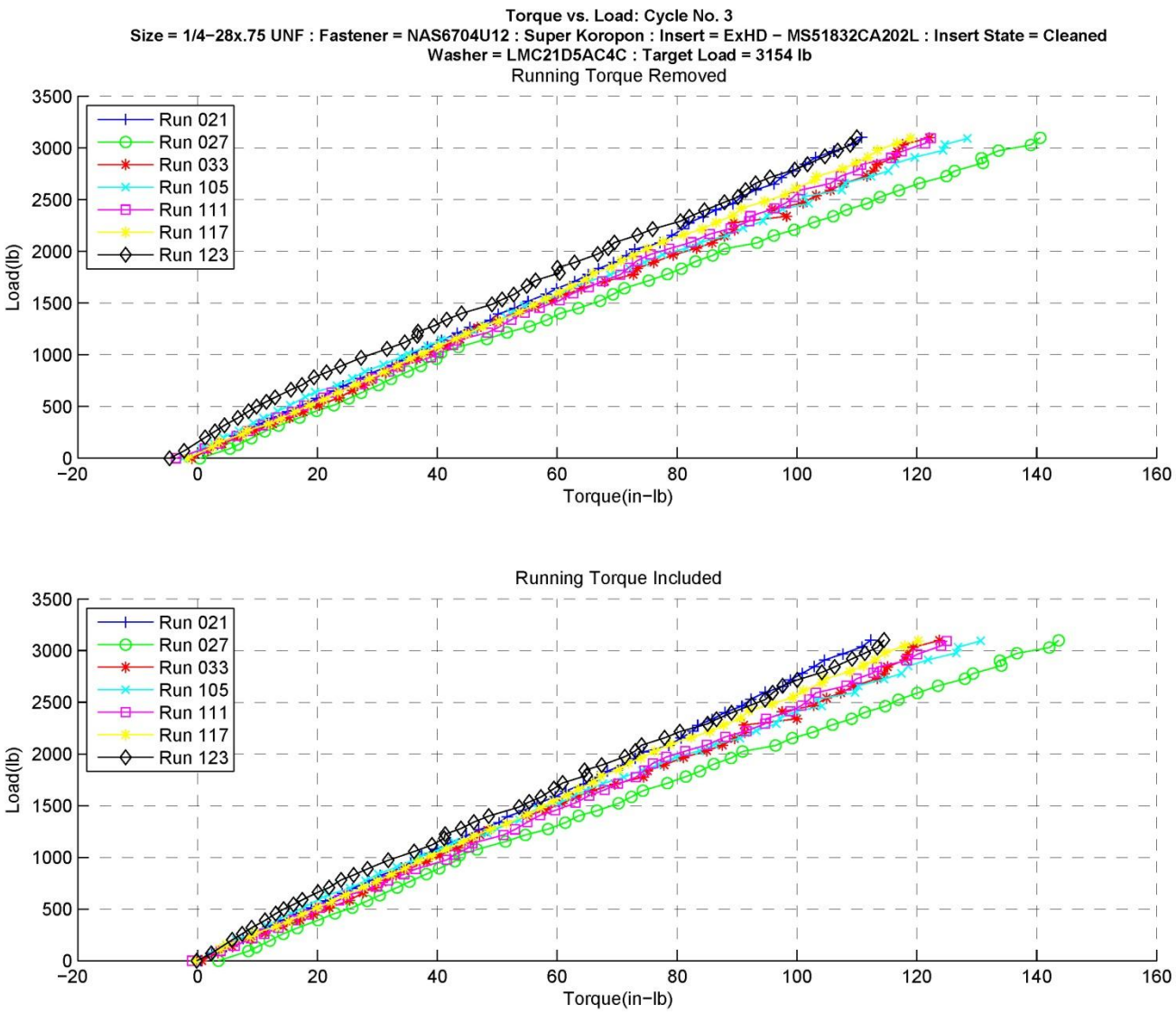

Running Torque Included
Run 011
Run 008
Run 017
Run 077
Run 083
Run 089
Run 101
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
−20
0
20
40
60
80
100
120
140
160
180

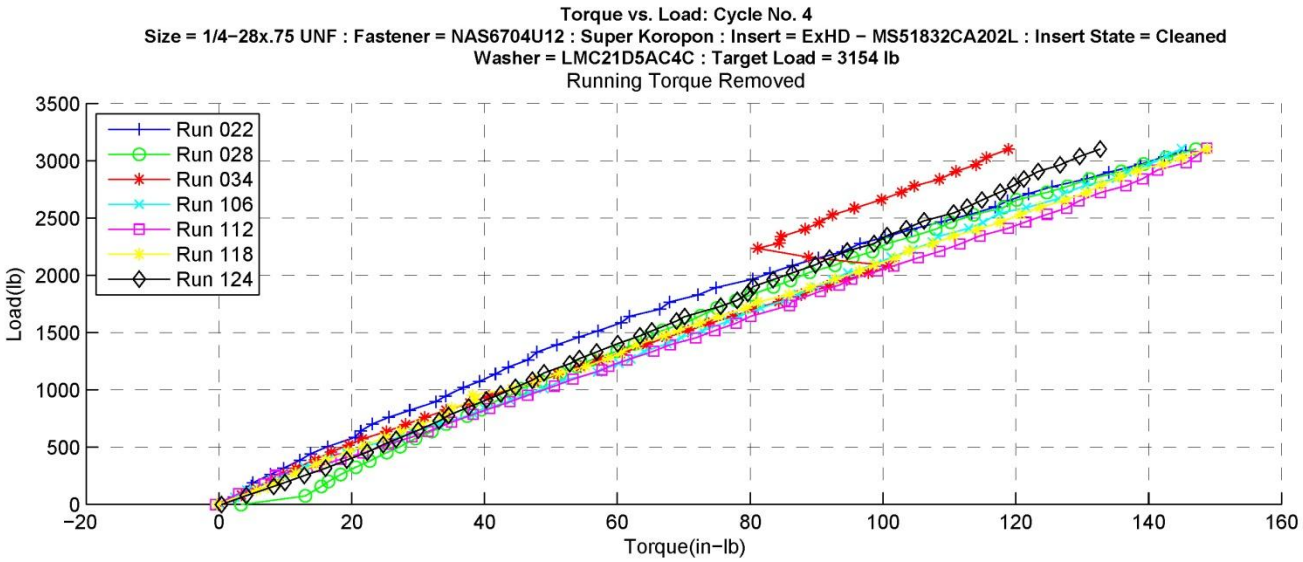

Torque vs. Load: Cycle No. 6
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Super Koropon : Insert = ExHD − MS51832CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 012
Run 009
Run 018
Run 078
Run 084
Run 090
Run 102
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
−20
0
20
40
60
80
100
120
140
160
180

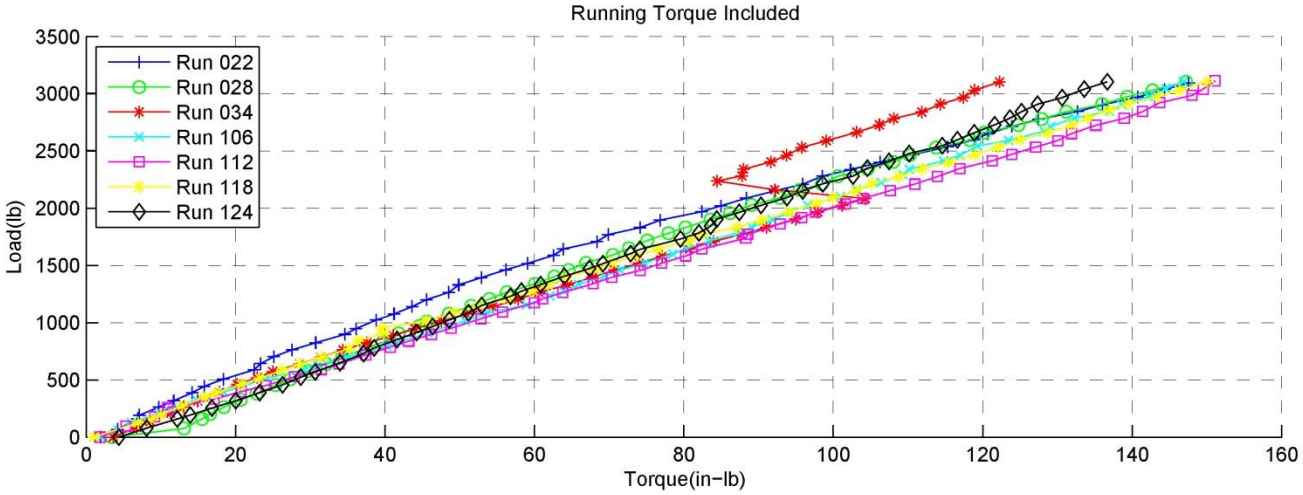

Running Torque Included
Run 012
Run 009
Run 018
Run 078
Run 084
Run 090
Run 102
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
−20
0
20
40
60
80
100
120
140
160
180

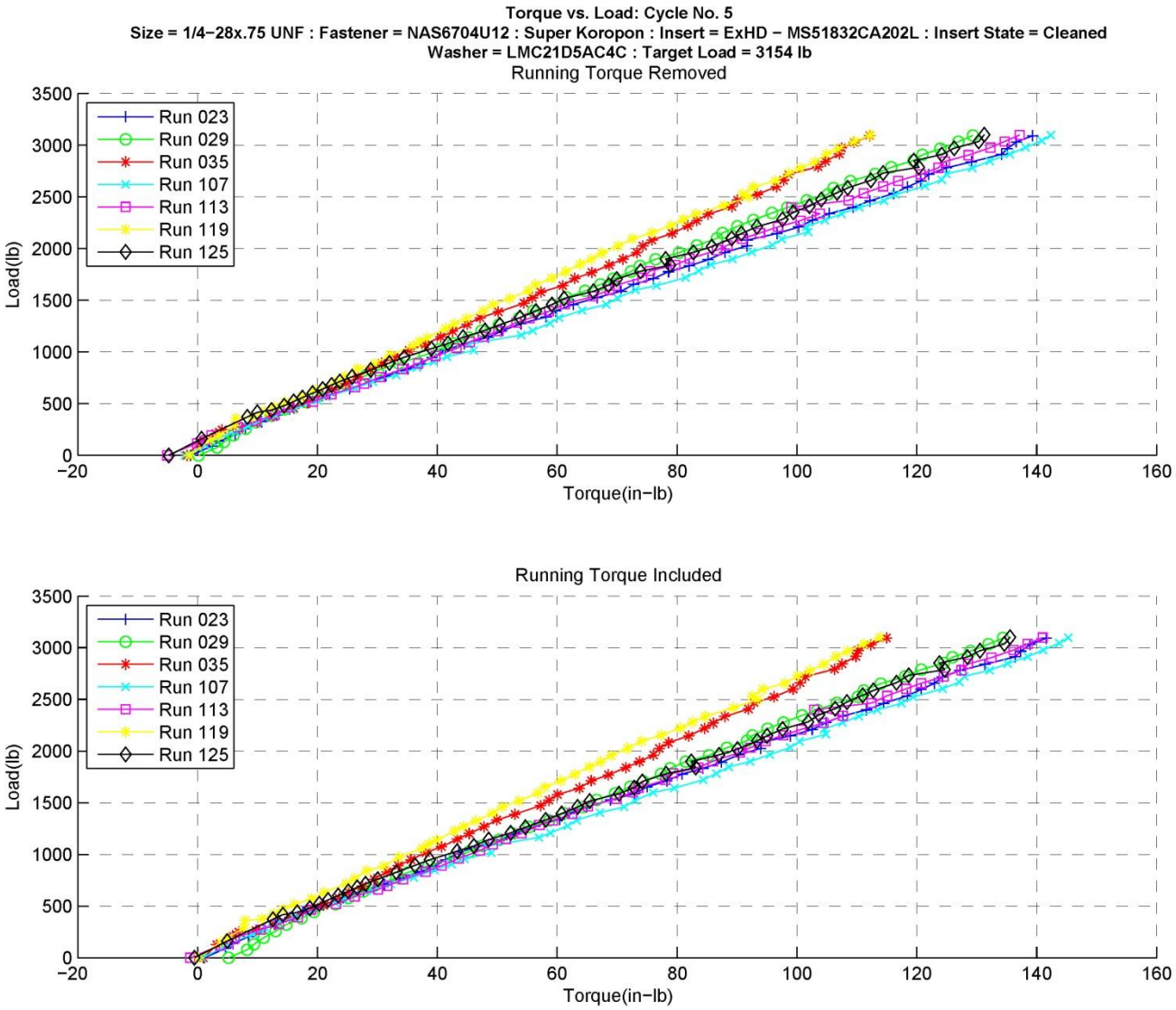

Torque vs. Load: Cycle No. 1
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Super Koropon : Insert = ExHD − MS51832CA202L : Insert State = Cleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Load(lb)
Torque(in−lb)
Run 019
Run 025
Run 031
Run 103
Run 109
Run 115
Run 121
Running Torque Included
Load(lb)
Torque(in−lb)
Run 019
Run 025
Run 031
Run 103
Run 109
Run 115
Run 121

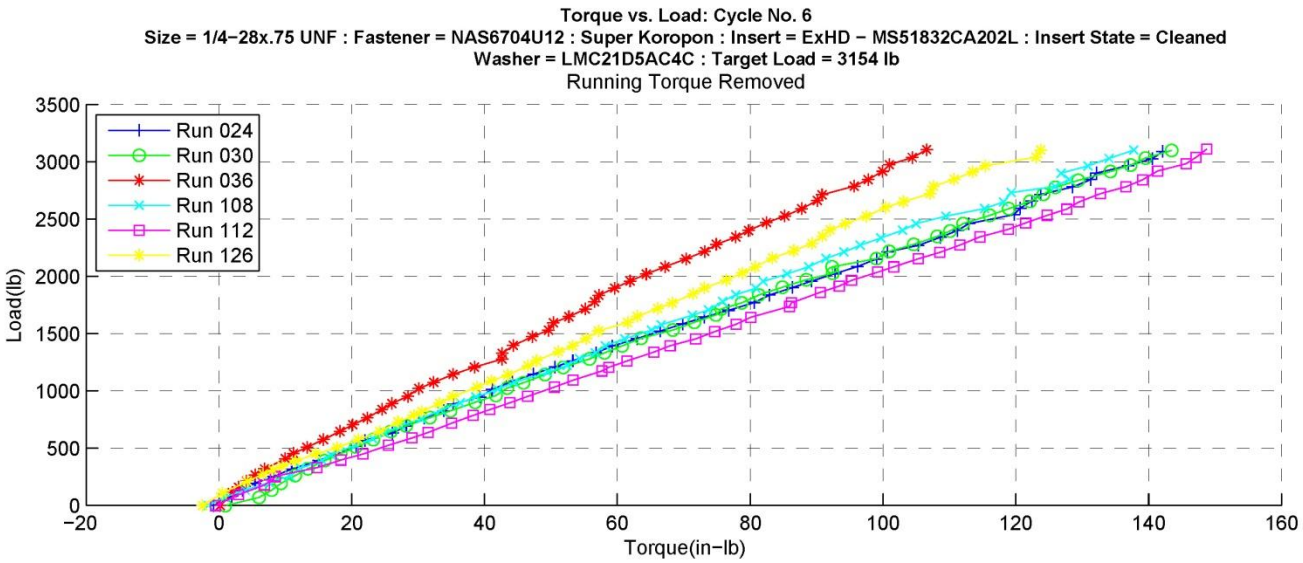

Torque vs. Load: Cycle No. 2
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Super Koropon : Insert = ExHD − MS51832CA202L : Insert State = Cleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Load(lb)
Torque(in−lb)
Run 020
Run 026
Run 032
Run 104
Run 110
Run 116
Run 122
Running Torque Included
Load(lb)
Torque(in−lb)
Run 020
Run 026
Run 032
Run 104
Run 110
Run 116
Run 122

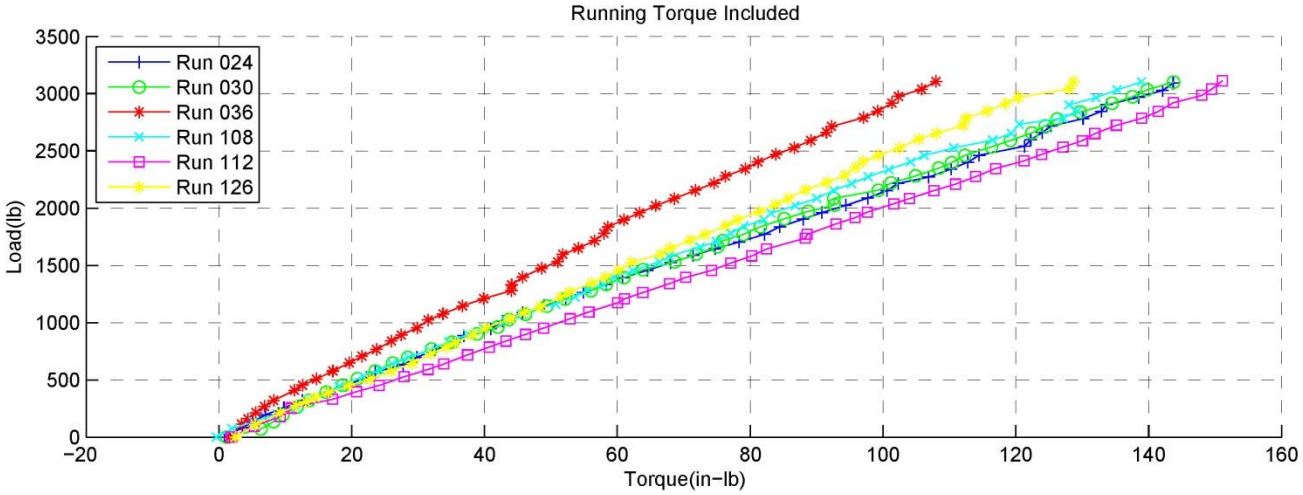

Torque vs. Load: Cycle No. 3
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Super Koropon : Insert = ExHD − MS51832CA202L : Insert State = Cleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Load(lb)
Torque(in−lb)
Run 021
Run 027
Run 033
Run 105
Run 111
Run 117
Run 123
Running Torque Included
Load(lb)
Torque(in−lb)
Run 021
Run 027
Run 033
Run 105
Run 111
Run 117
Run 123

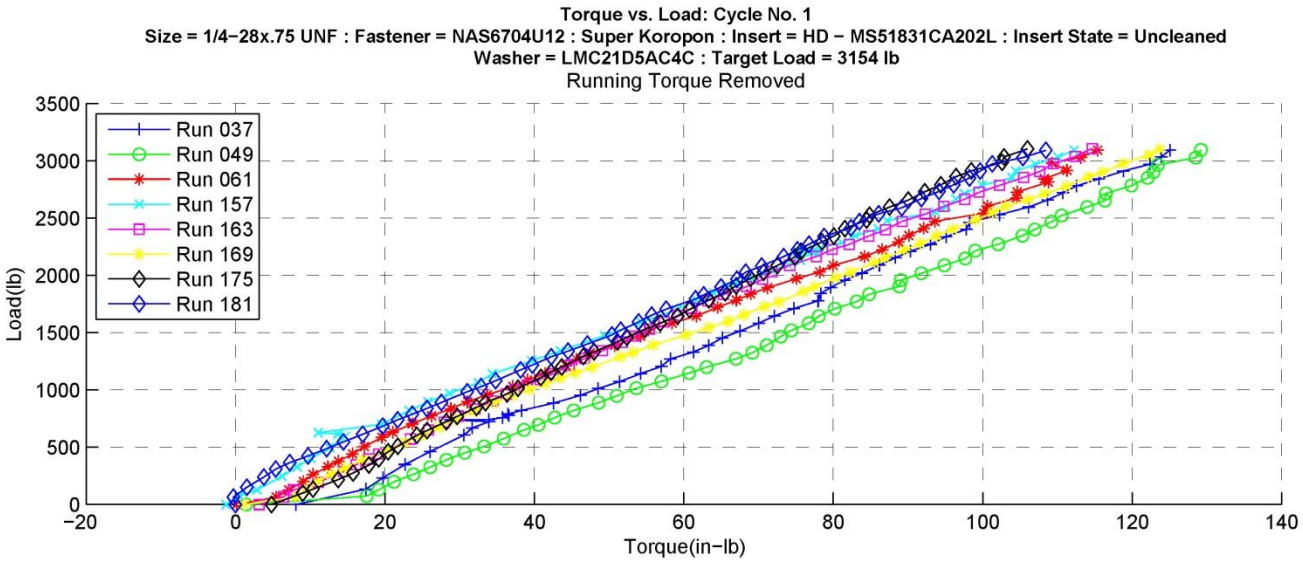

Torque vs. Load: Cycle No. 4
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Super Koropon : Insert = ExHD − MS51832CA202L : Insert State = Cleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 022
Run 028
Run 034
Run 106
Run 112
Run 118
Run 124
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
−20
0
20
40
60
80
100
120
140
160

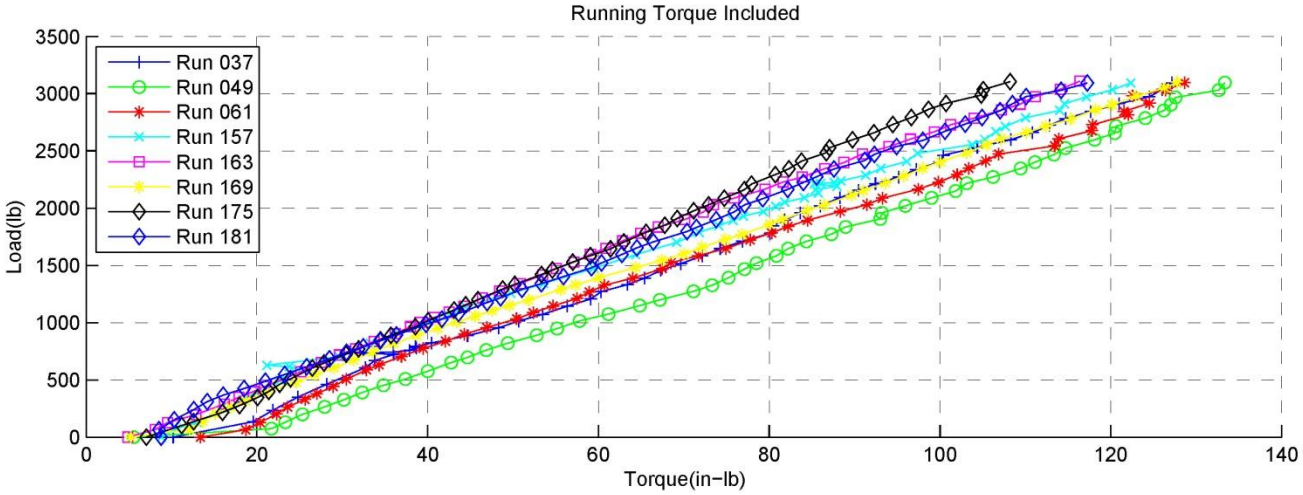

Running Torque Included
Run 022
Run 028
Run 034
Run 106
Run 112
Run 118
Run 124
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
120
140
160

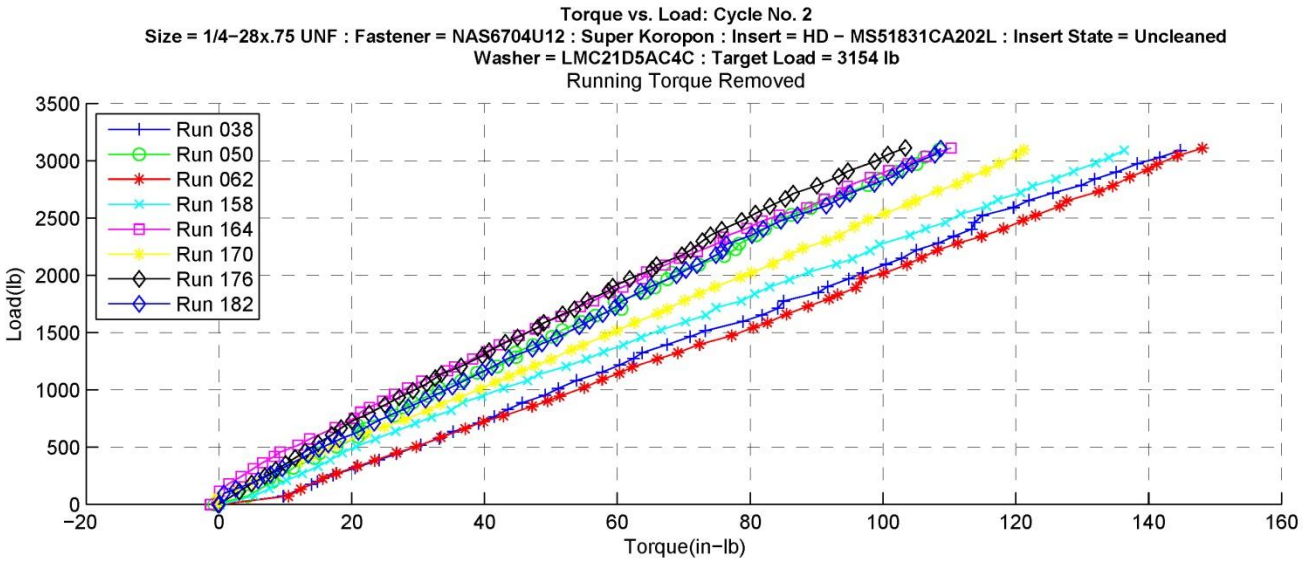

Torque vs. Load: Cycle No. 5
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Super Koropon : Insert = ExHD − MS51832CA202L : Insert State = Cleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Load(lb)
Torque(in−lb)
Run 023
Run 029
Run 035
Run 107
Run 113
Run 119
Run 125
Running Torque Included
Load(lb)
Torque(in−lb)
Run 023
Run 029
Run 035
Run 107
Run 113
Run 119
Run 125

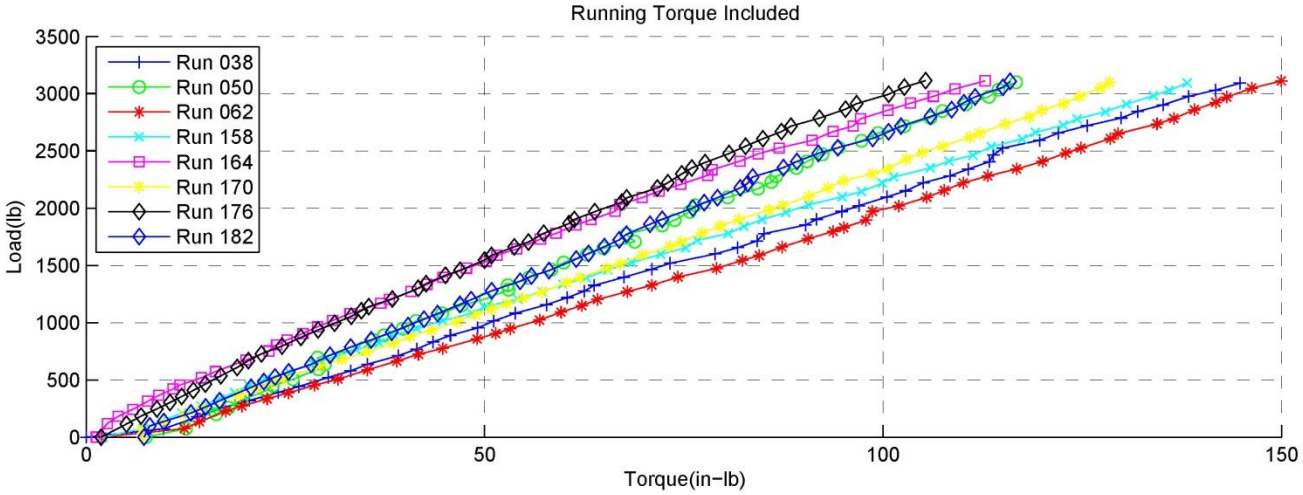

Torque vs. Load: Cycle No. 6
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Super Koropon : Insert = ExHD − MS51832CA202L : Insert State = Cleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 024
Run 030
Run 036
Run 108
Run 112
Run 126
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
−20
0
20
40
60
80
100
120
140
160

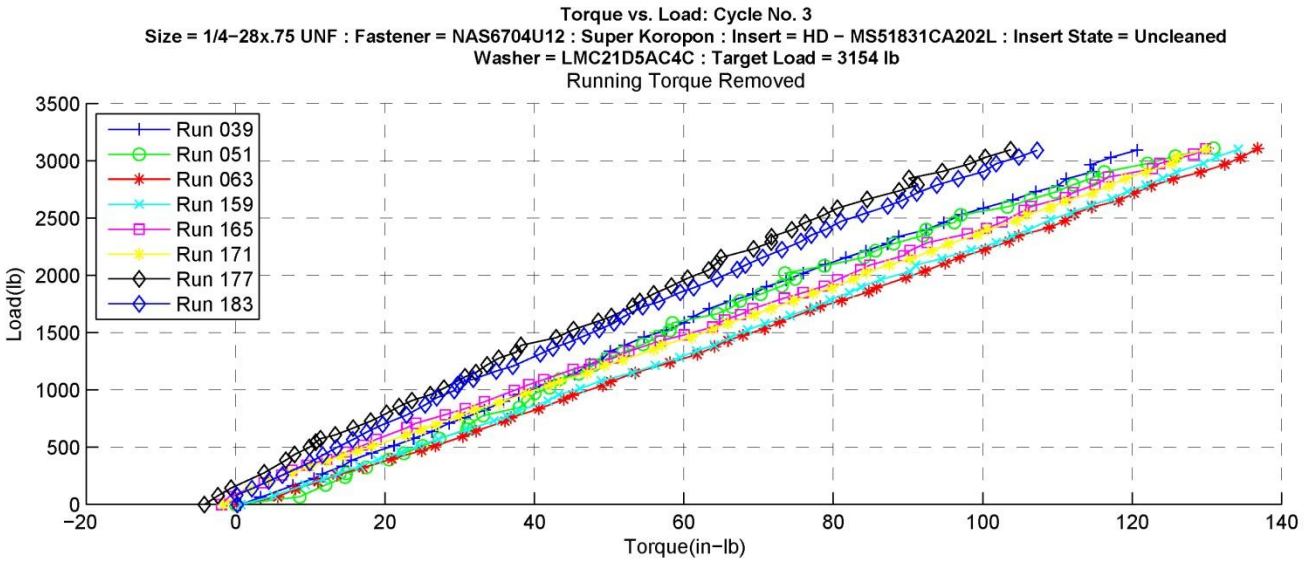

Running Torque Included
Run 024
Run 030
Run 036
Run 108
Run 112
Run 126
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
−20
0
20
40
60
80
100
120
140
160

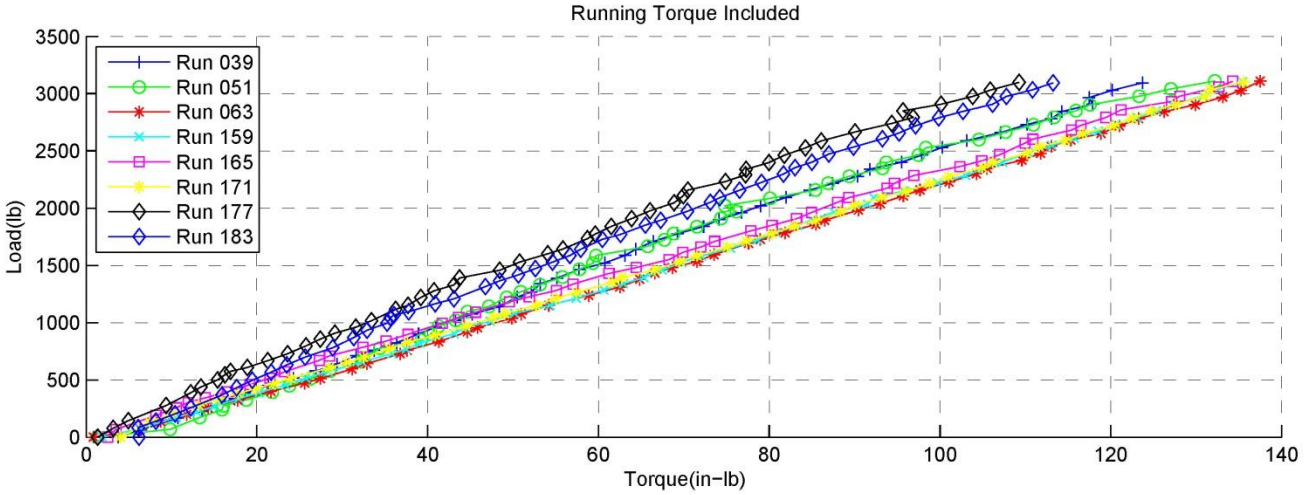

Torque vs. Load: Cycle No. 1
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Super Koropon : Insert = HD − MS51831CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 037
Run 049
Run 061
Run 157
Run 163
Run 169
Run 175
Run 181
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
−20
0
20
40
60
80
100
120
140

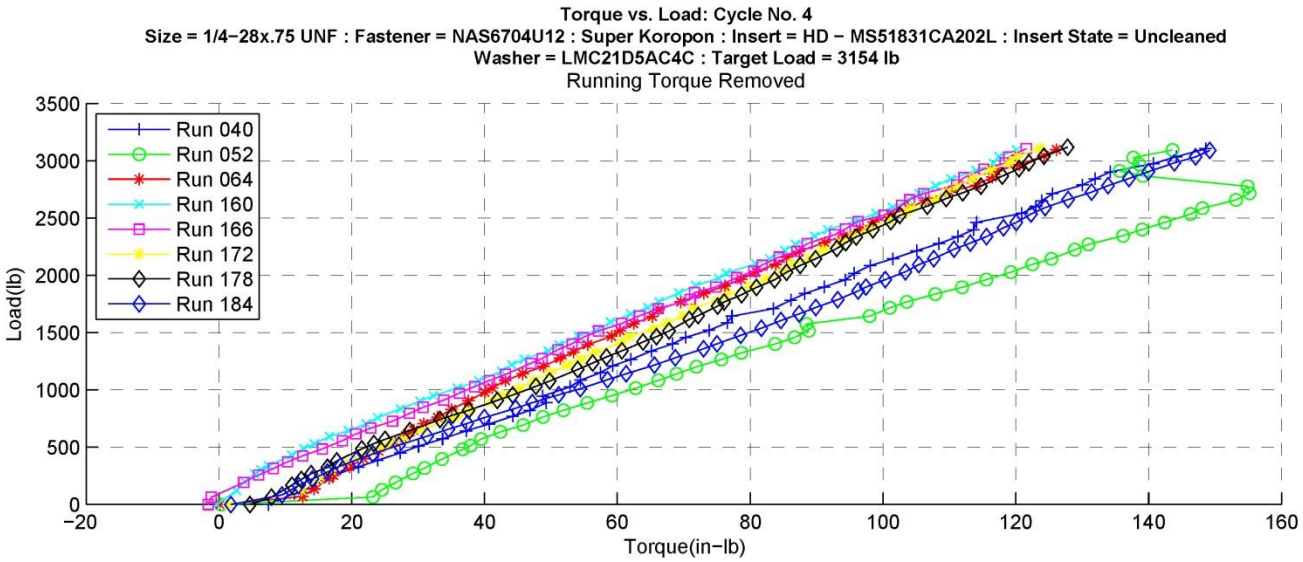

Running Torque Included
Run 037
Run 049
Run 061
Run 157
Run 163
Run 169
Run 175
Run 181
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
120
140

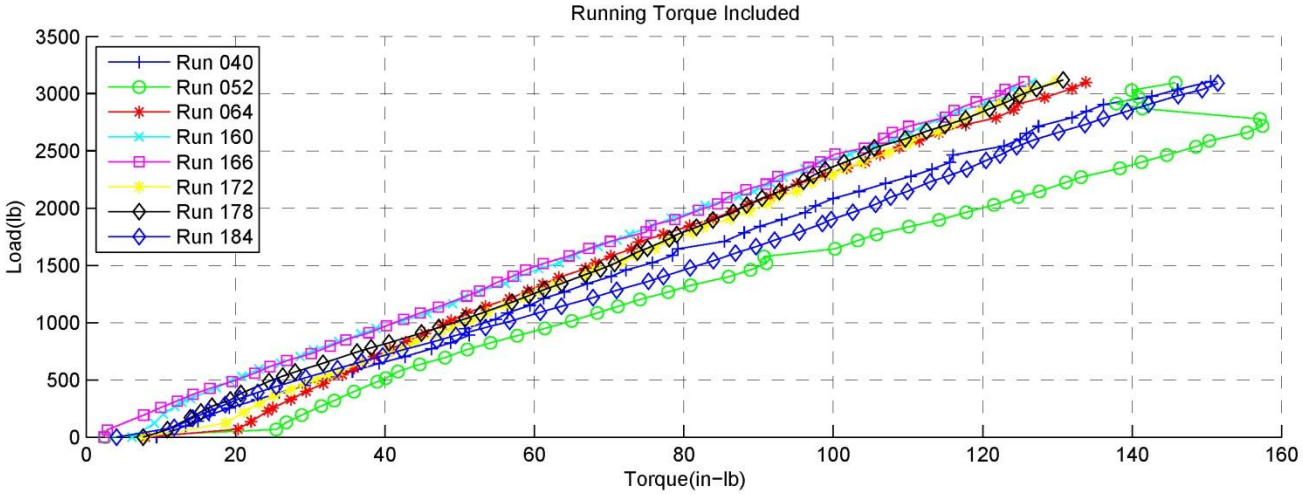

Torque vs. Load: Cycle No. 2
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Super Koropon : Insert = HD − MS51831CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 038
Run 050
Run 062
Run 158
Run 164
Run 170
Run 176
Run 182
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
−20
0
20
40
60
80
100
120
140
160

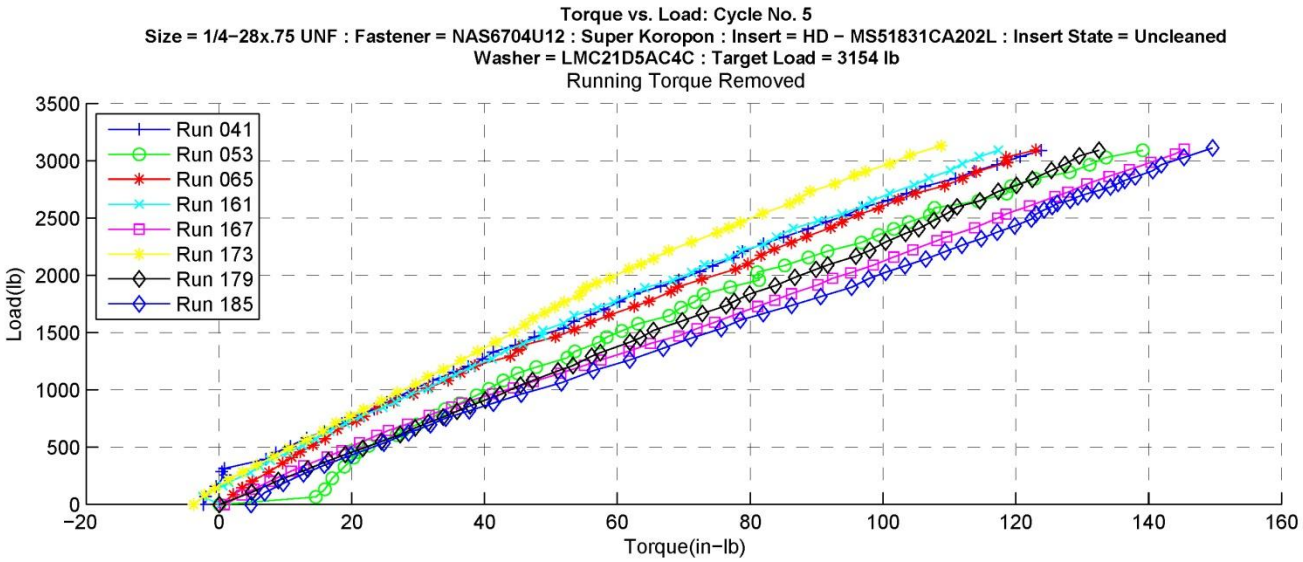

Running Torque Included
Run 038
Run 050
Run 062
Run 158
Run 164
Run 170
Run 176
Run 182
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
0
50
100
150

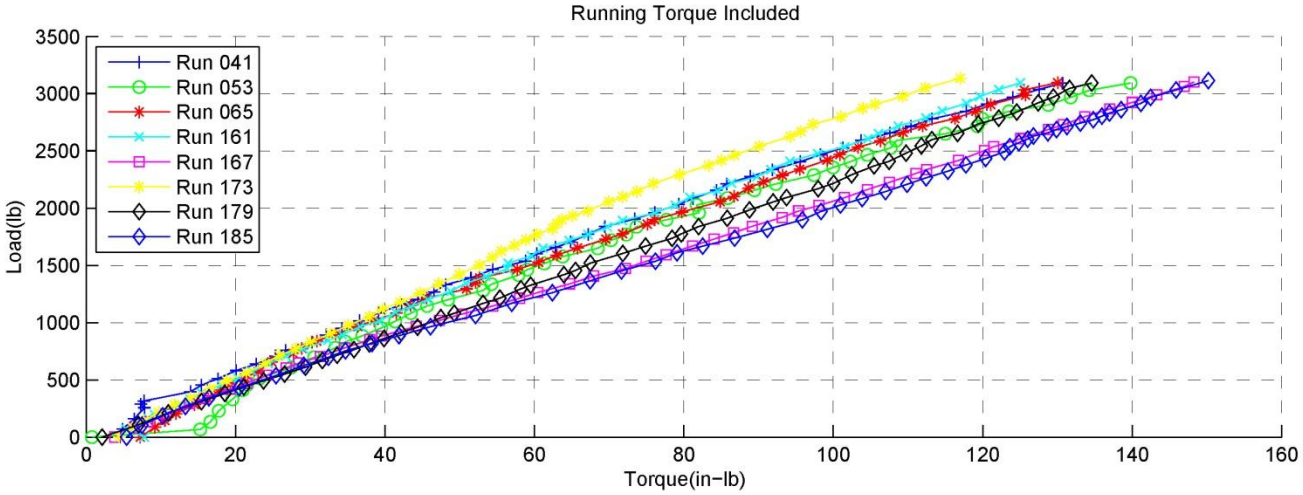

Torque vs. Load: Cycle No. 3
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Super Koropon : Insert = HD − MS51831CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 039
Run 051
Run 063
Run 159
Run 165
Run 171
Run 177
Run 183
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
−20
0
20
40
60
80
100
120
140

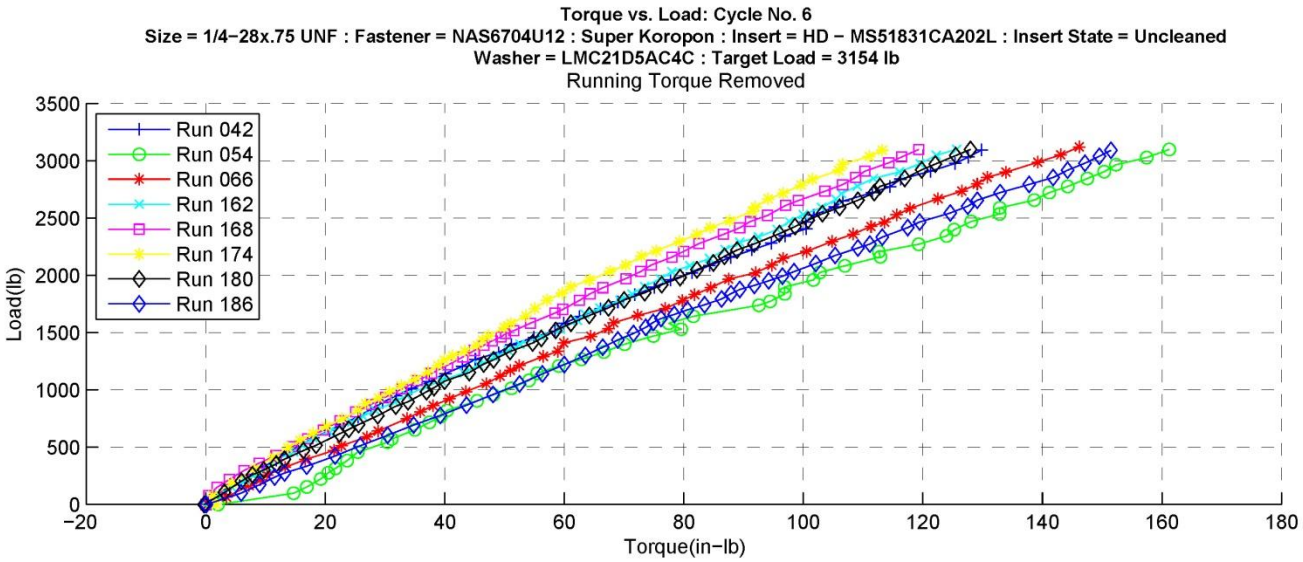

Running Torque Included
Run 039
Run 051
Run 063
Run 159
Run 165
Run 171
Run 177
Run 183
Load(lb)
Torque(in−lb)
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
120
140

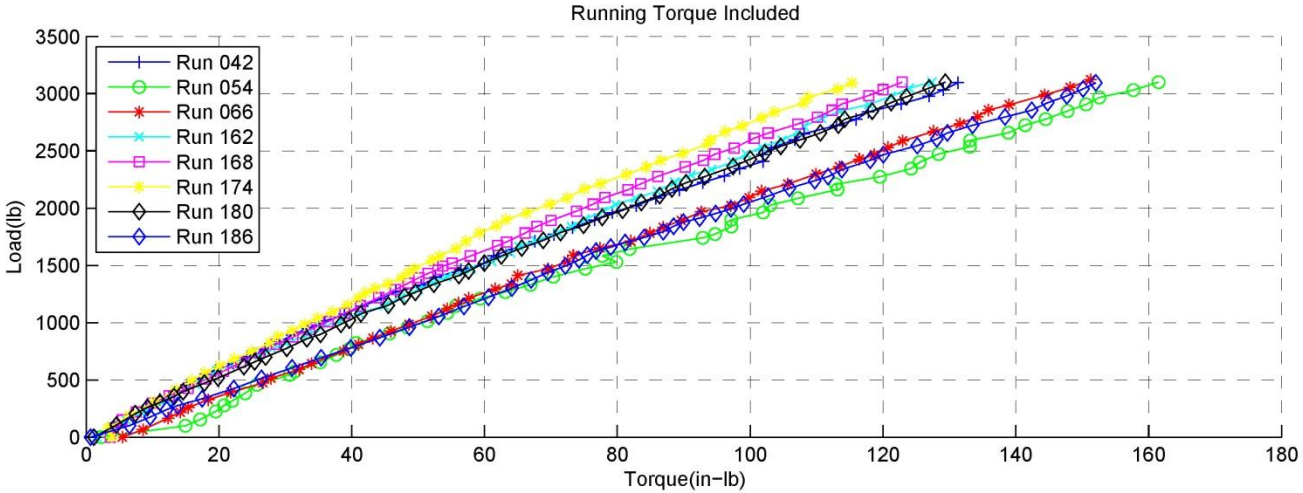

Torque vs. Load: Cycle No. 4
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Super Koropon : Insert = HD − MS51831CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 040
Run 052
Run 064
Run 160
Run 166
Run 172
Run 178
Run 184
Load(lb)
Torque(in−lb)


Running Torque Included
Run 040
Run 052
Run 064
Run 160
Run 166
Run 172
Run 178
Run 184
Load(lb)
Torque(in−lb)


Torque vs. Load: Cycle No. 5
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Super Koropon : Insert = HD − MS51831CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 041
Run 053
Run 065
Run 161
Run 167
Run 173
Run 179
Run 185
Load(lb)
Torque(in−lb)


Running Torque Included
Run 041
Run 053
Run 065
Run 161
Run 167
Run 173
Run 179
Run 185
Load(lb)
Torque(in−lb)


Torque vs. Load: Cycle No. 6
Size = 1/4−28x.75 UNF : Fastener = NAS6704U12 : Super Koropon : Insert = HD − MS51831CA202L : Insert State = Uncleaned
Washer = LMC21D5AC4C : Target Load = 3154 lb
Running Torque Removed
Run 042
Run 054
Run 066
Run 162
Run 168
Run 174
Run 180
Run 186
Load(lb)
Torque(in−lb)


Running Torque Included
Run 042
Run 054
Run 066
Run 162
Run 168
Run 174
Run 180
Run 186
Load(lb)
Torque(in−lb)

Appendix B:

Section 1	¼-28 Dry Torque Tension Plots
Section 2	¼-28 Wet Torque Tension Plots
Section 3	¼-28 Dry Running Torque Plots
Section 4	¼-28 Wet Running Torque Plots
Section 5	¼-28 Dry Cycle Plots: Torque vs. Load
Section 6	¼-28 Wet Cycle Plots: Torque vs. Load
Section 7	¼-28 Friction Coefficients
Section 8	¼-28 Test Plate Layouts
Section 9	¼-28 Dry Run Logs
Section 10	¼-28 Wet Run Logs

Table 1: Orion NESC Fastener Tests Summary - Individual DataSet Results

							Mean - Individual Cycles						Std Dev - Individual Cycles					
Set	Fastener	Lubrication	Insert	Insert State	N	90%	1	2	3	4	5	6	1	2	3	4	5	6
1	.25-28	Super Koropon	ExHD	Unclean	7	2.755	0.158	0.155	0.155	0.160	0.164	0.167	0.013	0.012	0.015	0.015	0.032	0.030
2	.25-28	Super Koropon	ExHD	Clean	7	2.755	0.160	0.162	0.157	0.182	0.167	0.172	0.018	0.014	0.014	0.014	0.016	0.021
3	.25-28	Super Koropon	HD	Clean	8	2.582	0.169	0.163	0.158	0.191	0.181	0.178	0.017	0.015	0.017	0.025	0.024	0.027
4	.25-28	Super Koropon	HD	Unclean	8	2.582	0.151	0.158	0.160	0.171	0.168	0.173	0.011	0.023	0.016	0.016	0.018	0.021
5	.25-28	None	ExHD	Unclean	2	20.581	0.315	0.387	0.435	0.359	0.374	0.415	0.052	0.040	0.001	0.000	0.038	0.049
6	.25-28	None	HD	Clean	2	20.581	0.376	0.441	0.461	0.415	0.538	0.533	0.035	0.010	0.004	0.028	0.005	0.007
7	.25-28	None	HD	Unclean	2	20.581	0.357	0.425	0.414	0.389	0.450	0.485	0.068	0.023	0.011	0.001	0.012	0.018

Table 2: Orion NESC Fastener Tests Summary - DataSet Grouping No. 1

					Individual Cycle Results														Combined Cycle Results			
							Mean							Standard Deviation									
Set	Fastener	Lubrication	Insert	Insert State	N	90%	1	2	3	4	5	6	1	2	3	4	5	6	N	90%	Mean	StdDev
1+2	.25-28	Super Koropon	ExHD	Unclean+Clean	14	2.109	0.159	0.159	0.156	0.171	0.166	0.170	0.015	0.013	0.014	0.018	0.024	0.025	84	1.646	0.163	0.019
3+4	.25-28	Super Koropon	HD	Unclean+Clean	16	2.033	0.160	0.161	0.159	0.181	0.174	0.176	0.017	0.019	0.016	0.023	0.022	0.024	96	1.646	0.168	0.022
6+7	.25-28	None	HD	Unclean+Clean	4	4.162	0.366	0.433	0.438	0.402	0.494	0.509	0.045	0.017	0.028	0.022	0.051	0.030	24	1.853	0.440	0.059

Table 3: Orion NESC Fastener Tests Summary - DataSet Grouping No. 2

					Individual Cycle Results														Combined Cycle Results			
							Mean							Standard Deviation									
Set	Fastener	Lubrication	Inserts	Insert State	N	90%	1	2	3	4	5	6	1	2	3	4	5	6	N	90%	Mean	StdDev
1+2+3+4	.25-28	Super Koropon	ExHD+HD	Unclean+Clean	30	1.777	0.160	0.160	0.158	0.176	0.170	0.173	0.016	0.016	0.015	0.021	0.023	0.024	180	1.646	0.166	0.021
5+6+7	.25-28	None	ExHD+HD	Unclean+Clean	6	3.006	0.349	0.418	0.437	0.388	0.454	0.478	0.050	0.032	0.022	0.028	0.076	0.058	36	1.725	0.421	0.062

Orion NESC Fastener Tests: Individual Friction Results

Table 4: ORION TEST RESULTS FOR 1/4-28x.75 UNF NAS6704U12 FASTENERS (160KSI

(Lubrication: Super Koropon, Hardware: Uncleaned)

TEST RUN	TEST CYCLES INTO LOCKING ExHD - MS51832CA202L KEENSERTS						INSERT
NUMBER	1	2	3	4	5	6	NUMBER
1	0.138	0.160	0.152	0.142	0.139	0.140	1
4	0.155	0.173	0.177	0.151	0.141	0.146	2
13	0.164	0.160	0.163	0.151	0.142	0.152	3
73	0.177	0.150	0.148	0.186	0.223	0.216	4
79	0.156	0.138	0.134	0.166	0.186	0.196	5
85	0.168	0.161	0.169	0.171	0.174	0.178	6
97	0.148	0.147	0.143	0.152	0.146	0.143	7

1.106	1.088	1.085	1.119	1.151	1.170	SUM
0.158	0.155	0.155	0.160	0.164	0.167	MEAN
0.156	0.160	0.152	0.152	0.146	0.152	MEDIAN
0.013	0.012	0.015	0.015	0.032	0.030	STDVA

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL

(With 95% Confidence for 90% of population)

(N = 7 : 90% = 2.755)

0.193833	0.187584	0.196999	0.201477	0.252229	0.249437	Kmax-90%
0.122296	0.12341	0.113065	0.118325	0.076573	0.084888	Kmin-90%

Orion NESC Fastener Tests: Individual Friction Results

Table 5: ORION TEST RESULTS FOR 1/4-28x.75 UNF NAS6704U12 FASTENERS (160KSI

(Lubrication: Super Koropon, Hardware: Cleaned)

TEST RUN	TEST CYCLES INTO LOCKING ExHD - MS51832CA202L KEENSERTS						INSERT
NUMBER	1	2	3	4	5	6	NUMBER
19	0.187	0.173	0.143	0.188	0.180	0.184	1
25	0.160	0.185	0.181	0.190	0.167	0.185	2
31	0.156	0.163	0.158	0.153	0.145	0.137	3
103	0.147	0.164	0.166	0.187	0.184	0.178	4
109	0.182	0.158	0.158	0.191	0.177	0.000	5
115	0.155	0.151	0.154	0.192	0.145	0.191	6
121	0.137	0.143	0.142	0.171	0.169	0.159	7
	1.123	1.136	1.102	1.272	1.168	1.034	SUM
	0.160	0.162	0.157	0.182	0.167	0.172	MEAN
	0.156	0.163	0.158	0.188	0.169	0.181	MEDIAN
	0.018	0.014	0.014	0.014	0.016	0.021	STDVA

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL

(With 95% Confidence for 90% of population)

(N = 7 : 90% = 2.755)

0.210284	0.200398	0.195067	0.221366	0.210887	0.228839	Kmax-90%
0.110605	0.12429	0.119717	0.142078	0.122691	0.115828	Kmin-90%

Orion NESC Fastener Tests: Individual Friction Results

Table 6: ORION TEST RESULTS FOR 1/4-28x.75 UNF NAS6704U12 FASTENERS (160KSI

(Lubrication: Super Koropon, Hardware: Cleaned)

TEST RUN	TEST CYCLES INTO LOCKING HD - MS51831CA202L KEENSERTS						INSERT
NUMBER	1	2	3	4	5	6	NUMBER
43	0.180	0.153	0.142	0.191	0.156	0.148	1
55	0.206	0.197	0.191	0.223	0.206	0.203	2
67	0.167	0.162	0.153	0.179	0.176	0.179	3
127	0.154	0.151	0.147	0.149	0.151	0.134	4
133	0.169	0.163	0.177	0.226	0.209	0.212	5
139	0.163	0.152	0.147	0.172	0.198	0.197	6
145	0.157	0.154	0.147	0.199	0.158	0.177	7
151	0.158	0.173	0.157	0.186	0.195	0.176	8

1.355	1.304	1.260	1.526	1.449	1.426	SUM
0.169	0.163	0.158	0.191	0.181	0.178	MEAN
0.165	0.158	0.150	0.189	0.186	0.178	MEDIAN
0.017	0.015	0.017	0.025	0.024	0.027	STDVA

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL

(With 95% Confidence for 90% of population)

(N = 8 : 90% = 2.582)

0.213281	0.202968	0.201837	0.256536	0.242396	0.247573	Kmax-90%
0.125358	0.123047	0.113272	0.12504	0.11996	0.108857	Kmin-90%

Orion NESC Fastener Tests: Individual Friction Results

Table 7: ORION TEST RESULTS FOR 1/4-28x.75 UNF NAS6704U12 FASTENERS (160KSI

(Lubrication: Super Koropon, Hardware: Uncleaned)

TEST RUN	TEST CYCLES INTO LOCKING HD - MS51831CA202L KEENSERTS						INSERT
NUMBER	1	2	3	4	5	6	NUMBER
37	0.162	0.187	0.156	0.191	0.160	0.168	1
49	0.167	0.140	0.168	0.186	0.180	0.208	2
61	0.149	0.190	0.176	0.163	0.159	0.187	3
157	0.145	0.176	0.173	0.155	0.152	0.162	4
163	0.148	0.142	0.167	0.157	0.187	0.154	5
169	0.160	0.156	0.168	0.159	0.139	0.146	6
175	0.137	0.133	0.134	0.164	0.171	0.165	7
181	0.140	0.140	0.139	0.193	0.192	0.196	8

1.207	1.265	1.281	1.367	1.341	1.386	SUM
0.151	0.158	0.160	0.171	0.168	0.173	MEAN
0.148	0.149	0.167	0.163	0.166	0.166	MEDIAN
0.011	0.023	0.016	0.016	0.018	0.021	STDVA

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL
(With 95% Confidence for 90% of population)
(N = 8 : 90% = 2.582)

0.178715	0.21827	0.200979	0.212639	0.215118	0.228766	Kmax-90%
0.12298	0.097977	0.11923	0.129161	0.120008	0.117789	Kmin-90%

Orion NESC Fastener Tests: Individual Friction Results

Table 8: ORION TEST RESULTS FOR 1/4-28x.75 UNF NAS6704U12 FASTENERS (160KSI

(Lubrication: No Lube, Hardware: Uncleaned)

TEST RUN	TEST CYCLES INTO LOCKING ExHD - MS51832CA202L KEENSERTS						INSERT
NUMBER	1	2	3	4	5	6	NUMBER
7	0.278	0.359	0.436	0.359	0.347	0.381	1
13	0.351	0.415	0.435	0.359	0.401	0.450	2

0.630	0.775	0.871	0.718	0.748	0.831	SUM
0.315	0.387	0.435	0.359	0.374	0.415	MEAN
0.315	0.387	0.435	0.359	0.374	0.415	MEDIAN
0.052	0.040	0.001	0.000	0.038	0.049	STDVA

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL

(With 95% Confidence for 90% of population)

(N = 2 : 90% = 20.581)

1.37976	1.201321	0.449153	0.365287	1.158116	1.419972	Kmax-90%
-0.75003	-0.42655	0.421459	0.353208	-0.41037	-0.58924	Kmin-90%

Orion NESC Fastener Tests: Individual Friction Results

Table 9: ORION TEST RESULTS FOR 1/4-28x.75 UNF NAS6704U12 FASTENERS (160KSI

(Lubrication: No Lube, Hardware: Cleaned)

TEST RUN	TEST CYCLES INTO LOCKING HD - MS51831CA202L KEENSERTS						INSERT
NUMBER	1	2	3	4	5	6	NUMBER
19	0.351	0.433	0.458	0.395	0.535	0.538	1
25	0.401	0.448	0.465	0.435	0.542	0.527	2

0.752	0.881	0.923	0.829	1.077	1.065	SUM
0.376	0.441	0.461	0.415	0.538	0.533	MEAN
0.376	0.441	0.461	0.415	0.538	0.533	MEDIAN
0.035	0.010	0.004	0.028	0.005	0.007	STDVA

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL
(With 95% Confidence for 90% of population)
(N = 2 : 90% = 20.581)

1.095988	0.649547	0.553766	0.999573	0.642924	0.685305	Kmax-90%
-0.34366	0.231576	0.369086	-0.17028	0.434017	0.379904	Kmin-90%

Orion NESC Fastener Tests: Individual Friction Results

Table 10: ORION TEST RESULTS FOR 1/4-28x.75 UNF NAS6704U12 FASTENERS (160KSI

(Lubrication: No Lube, Hardware: Uncleaned)

TEST RUN NUMBER	TEST CYCLES INTO LOCKING HD - MS51831CA202L KEENSERTS 1	2	3	4	5	6	INSERT NUMBER
31	0.309	0.409	0.421	0.389	0.442	0.472	1
34	0.405	0.442	0.406	0.390	0.459	0.498	2

0.714	0.851	0.827	0.779	0.901	0.969	SUM
0.357	0.425	0.414	0.389	0.450	0.485	MEAN
0.357	0.425	0.414	0.389	0.450	0.485	MEDIAN
0.068	0.023	0.011	0.001	0.012	0.018	STDVA

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL
(With 95% Confidence for 90% of population)
(N = 2 : 90% = 20.581)

1.752973	0.905442	0.63951	0.409917	0.69783	0.864877	Kmax-90%
-1.03937	-0.0546	0.187879	0.368901	0.202815	0.104505	Kmin-90%

Orion NESC Fastener Tests: DataSet Grouping No. 1 Friction Results

Table 11: ORION TEST RESULTS FOR 1/4-28x.75 UNF NAS6704U12 FASTENERS (160KSI)

(Lubrication: Super Koropon)

TEST RUN NUMBER	TEST CYCLES INTO LOCKING KEENSERTS 1	2	3	4	5	6	INSERT TYPE	INSERT STATE
1	0.138	0.160	0.152	0.142	0.139	0.140	ExHD - MS51832CA202L	Uncleaned
4	0.155	0.173	0.177	0.151	0.141	0.146	ExHD - MS51832CA202L	Uncleaned
13	0.164	0.160	0.163	0.151	0.142	0.152	ExHD - MS51832CA202L	Uncleaned
73	0.177	0.150	0.148	0.186	0.223	0.216	ExHD - MS51832CA202L	Uncleaned
79	0.156	0.138	0.134	0.166	0.186	0.196	ExHD - MS51832CA202L	Uncleaned
85	0.168	0.161	0.169	0.171	0.174	0.178	ExHD - MS51832CA202L	Uncleaned
97	0.148	0.147	0.143	0.152	0.146	0.143	ExHD - MS51832CA202L	Uncleaned
19	0.187	0.173	0.143	0.188	0.180	0.184	ExHD - MS51832CA202L	Cleaned
25	0.160	0.185	0.181	0.190	0.167	0.185	ExHD - MS51832CA202L	Cleaned
31	0.156	0.163	0.158	0.153	0.145	0.137	ExHD - MS51832CA202L	Cleaned
103	0.147	0.164	0.166	0.187	0.184	0.178	ExHD - MS51832CA202L	Cleaned
109	0.182	0.158	0.158	0.191	0.177	0.000	ExHD - MS51832CA202L	Cleaned
115	0.155	0.151	0.154	0.192	0.145	0.191	ExHD - MS51832CA202L	Cleaned
121	0.137	0.143	0.142	0.171	0.169	0.159	ExHD - MS51832CA202L	Cleaned

STATISTICAL RESULTS FOR INDIVIDUAL CYCLES

2.230	2.225	2.187	2.391	2.318	2.204	SUM
0.159	0.159	0.156	0.171	0.166	0.170	MEAN
0.156	0.160	0.156	0.171	0.168	0.178	MEDIAN
0.015	0.013	0.014	0.018	0.024	0.025	STDVA

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL
(With 95% Confidence for 90% of population)
(N = 14 : 90% = 2.109)

0.191265	0.185870	0.185656	0.209058	0.216773	0.222407	Kmax-90%
0.127244	0.131971	0.126768	0.132564	0.114418	0.116823	Kmin-90%

STATISTICAL RESULTS FOR COMBINED CYCLES

Sum	13.555
Mean	0.163
Median	0.164
Standard Deviation	0.019

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL
(With 95% Confidence for 90% of population)
(N = 84 : 90% = 1.646)

Kmax-90%	0.194678
Kmin-90%	0.132194

Orion NESC Fastener Tests: DataSet Grouping No. 1 Friction Results

Table 12: ORION TEST RESULTS FOR 1/4-28x.75 UNF NAS6704U12 FASTENERS (160KSI)

(Lubrication: Super Koropon)

TEST RUN NUMBER	TEST CYCLES INTO LOCKING KEENSERTS 1	2	3	4	5	6	INSERT TYPE	INSERT STATE
43	0.180	0.153	0.142	0.191	0.156	0.148	HD - MS51831CA202L	Cleaned
55	0.206	0.197	0.191	0.223	0.206	0.203	HD - MS51831CA202L	Cleaned
67	0.167	0.162	0.153	0.179	0.176	0.179	HD - MS51831CA202L	Cleaned
127	0.154	0.151	0.147	0.149	0.151	0.134	HD - MS51831CA202L	Cleaned
133	0.169	0.163	0.177	0.226	0.209	0.212	HD - MS51831CA202L	Cleaned
139	0.163	0.152	0.147	0.172	0.198	0.197	HD - MS51831CA202L	Cleaned
145	0.157	0.154	0.147	0.199	0.158	0.177	HD - MS51831CA202L	Cleaned
151	0.158	0.173	0.157	0.186	0.195	0.176	HD - MS51831CA202L	Cleaned
37	0.162	0.187	0.156	0.191	0.160	0.168	HD - MS51831CA202L	Uncleaned
49	0.167	0.140	0.168	0.186	0.180	0.208	HD - MS51831CA202L	Uncleaned
61	0.149	0.190	0.176	0.163	0.159	0.187	HD - MS51831CA202L	Uncleaned
157	0.145	0.176	0.173	0.155	0.152	0.162	HD - MS51831CA202L	Uncleaned
163	0.148	0.142	0.167	0.157	0.187	0.154	HD - MS51831CA202L	Uncleaned
169	0.160	0.156	0.168	0.159	0.139	0.146	HD - MS51831CA202L	Uncleaned
175	0.137	0.133	0.134	0.164	0.171	0.165	HD - MS51831CA202L	Uncleaned
181	0.140	0.140	0.139	0.193	0.192	0.196	HD - MS51831CA202L	Uncleaned

STATISTICAL RESULTS FOR INDIVIDUAL CYCLES

2.561	2.569	2.541	2.894	2.790	2.812	SUM
0.160	0.161	0.159	0.181	0.174	0.176	MEAN
0.159	0.155	0.156	0.182	0.174	0.177	MEDIAN
0.017	0.019	0.016	0.023	0.022	0.024	STDVA

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL
(With 95% Confidence for 90% of population)
(N = 16 : 90% = 2.033)

0.194141	0.199743	0.191354	0.227648	0.218448	0.223802	Kmax-90%
0.126026	0.121388	0.126305	0.134040	0.130293	0.127690	Kmin-90%

STATISTICAL RESULTS FOR COMBINED CYCLES

Sum	16.167
Mean	0.168
Median	0.163
Standard Deviation	0.022

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL
(With 95% Confidence for 90% of population)
(N = 96 : 90% = 1.646)

Kmax-90%	0.204018
Kmin-90%	0.132795

Orion NESC Fastener Tests: DataSet Grouping No. 1 Friction Results

Table 13: ORION TEST RESULTS FOR 1/4-28x.75 UNF NAS6704U12 FASTENERS (160KSI)

(Lubrication: No Lube)

TEST RUN NUMBER	TEST CYCLES INTO LOCKING KEENSERTS 1	2	3	4	5	6	INSERT TYPE	INSERT STATE
19	0.351	0.433	0.458	0.395	0.535	0.538	HD - MS51831CA202L	Cleaned
25	0.401	0.448	0.465	0.435	0.542	0.527	HD - MS51831CA202L	Cleaned
31	0.309	0.409	0.421	0.389	0.442	0.472	HD - MS51831CA202L	Uncleaned
34	0.405	0.442	0.406	0.390	0.459	0.498	HD - MS51831CA202L	Uncleaned

STATISTICAL RESULTS FOR INDIVIDUAL CYCLES

1.466	1.732	1.750	1.608	1.978	2.035	SUM
0.366	0.433	0.438	0.402	0.494	0.509	MEAN
0.376	0.438	0.440	0.392	0.497	0.513	MEDIAN
0.045	0.017	0.028	0.022	0.051	0.030	STDVA

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL
(With 95% Confidence for 90% of population)
(N = 4 : 90% = 4.162)

0.555694	0.504124	0.555741	0.493397	0.708520	0.633323	Kmax-90%
0.177276	0.361859	0.319379	0.310661	0.280273	0.383973	Kmin-90%

STATISTICAL RESULTS FOR COMBINED CYCLES

Sum	10.568
Mean	0.440
Median	0.438
Standard Deviation	0.059

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL
(With 95% Confidence for 90% of population)
(N = 24 : 90% = 1.853)

Kmax-90%	0.549541
Kmin-90%	0.331162

Orion NESC Fastener Tests: DataSet Grouping No. 2 Friction Results

Table 14: ORION TEST RESULTS FOR 1/4-28x.75 UNF NAS6704U12 FASTENERS (160KSI)
(Lubrication: Super Koropon)

TEST RUN	TEST CYCLES INTO LOCKING KEENSERTS						INSERT	INSERT
NUMBER	1	2	3	4	5	6	TYPE	STATE
1	0.138	0.160	0.152	0.142	0.139	0.140	ExHD - MS51832CA202L	Uncleaned
4	0.155	0.173	0.177	0.151	0.141	0.146	ExHD - MS51832CA202L	Uncleaned
13	0.164	0.160	0.163	0.151	0.142	0.152	ExHD - MS51832CA202L	Uncleaned
73	0.177	0.150	0.148	0.186	0.223	0.216	ExHD - MS51832CA202L	Uncleaned
79	0.156	0.138	0.134	0.166	0.186	0.196	ExHD - MS51832CA202L	Uncleaned
85	0.168	0.161	0.169	0.171	0.174	0.178	ExHD - MS51832CA202L	Uncleaned
97	0.148	0.147	0.143	0.152	0.146	0.143	ExHD - MS51832CA202L	Uncleaned
19	0.187	0.173	0.143	0.188	0.180	0.184	ExHD - MS51832CA202L	Cleaned
25	0.160	0.185	0.181	0.190	0.167	0.185	ExHD - MS51832CA202L	Cleaned
31	0.156	0.163	0.158	0.153	0.145	0.137	ExHD - MS51832CA202L	Cleaned
103	0.147	0.164	0.166	0.187	0.184	0.178	ExHD - MS51832CA202L	Cleaned
109	0.182	0.158	0.158	0.191	0.177	0.000	ExHD - MS51832CA202L	Cleaned
115	0.155	0.151	0.154	0.192	0.145	0.191	ExHD - MS51832CA202L	Cleaned
121	0.137	0.143	0.142	0.171	0.169	0.159	ExHD - MS51832CA202L	Cleaned
43	0.180	0.153	0.142	0.191	0.156	0.148	HD - MS51831CA202L	Cleaned
55	0.206	0.197	0.191	0.223	0.206	0.203	HD - MS51831CA202L	Cleaned
67	0.167	0.162	0.153	0.179	0.176	0.179	HD - MS51831CA202L	Cleaned
127	0.154	0.151	0.147	0.149	0.151	0.134	HD - MS51831CA202L	Cleaned
133	0.169	0.163	0.177	0.226	0.209	0.212	HD - MS51831CA202L	Cleaned
139	0.163	0.152	0.147	0.172	0.198	0.197	HD - MS51831CA202L	Cleaned
145	0.157	0.154	0.147	0.199	0.158	0.177	HD - MS51831CA202L	Cleaned
151	0.158	0.173	0.157	0.186	0.195	0.176	HD - MS51831CA202L	Cleaned
37	0.162	0.187	0.156	0.191	0.160	0.168	HD - MS51831CA202L	Uncleaned
49	0.167	0.140	0.168	0.186	0.180	0.208	HD - MS51831CA202L	Uncleaned
61	0.149	0.190	0.176	0.163	0.159	0.187	HD - MS51831CA202L	Uncleaned
157	0.145	0.176	0.173	0.155	0.152	0.162	HD - MS51831CA202L	Uncleaned
163	0.148	0.142	0.167	0.157	0.187	0.154	HD - MS51831CA202L	Uncleaned
169	0.160	0.156	0.168	0.159	0.139	0.146	HD - MS51831CA202L	Uncleaned
175	0.137	0.133	0.134	0.164	0.171	0.165	HD - MS51831CA202L	Uncleaned
181	0.140	0.140	0.139	0.193	0.192	0.196	HD - MS51831CA202L	Uncleaned

STATISTICAL RESULTS FOR INDIVIDUAL CYCLES

4.791	4.794	4.728	5.285	5.108	5.016	SUM
0.160	0.160	0.158	0.176	0.170	0.173	MEAN
0.157	0.159	0.156	0.176	0.170	0.177	MEDIAN
0.016	0.016	0.015	0.021	0.023	0.024	STDVA

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL
(With 95% Confidence for 90% of population)
(N = 30 : 90% = 1.777)

0.187715	0.188779	0.184056	0.213753	0.211067	0.237291	Kmax-90%
0.131679	0.130817	0.131160	0.138571	0.129484	0.097138	Kmin-90%

STATISTICAL RESULTS FOR COMBINED CYCLES

Sum	29.722
Mean	0.166
Median	0.165
Standard Deviation	0.021

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL
(With 95% Confidence for 90% of population)
(N = 180 : 90% = 1.646)

Kmax-90%	0.199954
Kmin-90%	0.132380

Orion NESC Fastener Tests: DataSet Grouping No. 2 Friction Results

Table 15: ORION TEST RESULTS FOR 1/4-28x.75 UNF NAS6704U12 FASTENERS (160KSI)
(Lubrication: No Lube)

TEST RUN	TEST CYCLES INTO LOCKING KEENSERTS						INSERT	INSERT
NUMBER	1	2	3	4	5	6	TYPE	STATE
7	0.278	0.359	0.436	0.359	0.347	0.381	ExHD - MS51832CA202L	Uncleaned
13	0.351	0.415	0.435	0.359	0.401	0.450	ExHD - MS51832CA202L	Uncleaned
19	0.351	0.433	0.458	0.395	0.535	0.538	HD - MS51831CA202L	Cleaned
25	0.401	0.448	0.465	0.435	0.542	0.527	HD - MS51831CA202L	Cleaned
31	0.309	0.409	0.421	0.389	0.442	0.472	HD - MS51831CA202L	Uncleaned
34	0.405	0.442	0.406	0.390	0.459	0.498	HD - MS51831CA202L	Uncleaned

STATISTICAL RESULTS FOR INDIVIDUAL CYCLES

2.096	2.507	2.621	2.327	2.725	2.865	SUM
0.349	0.418	0.437	0.388	0.454	0.478	MEAN
0.351	0.424	0.435	0.389	0.450	0.485	MEDIAN
0.050	0.032	0.022	0.028	0.076	0.058	STDVA

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL
(With 95% Confidence for 90% of population)
(N = 6 : 90% = 3.006)

0.499157	0.514855	0.503024	0.471573	0.682206	0.651159	Kmax-90%
0.199400	0.320726	0.370593	0.303964	0.226237	0.303948	Kmin-90%

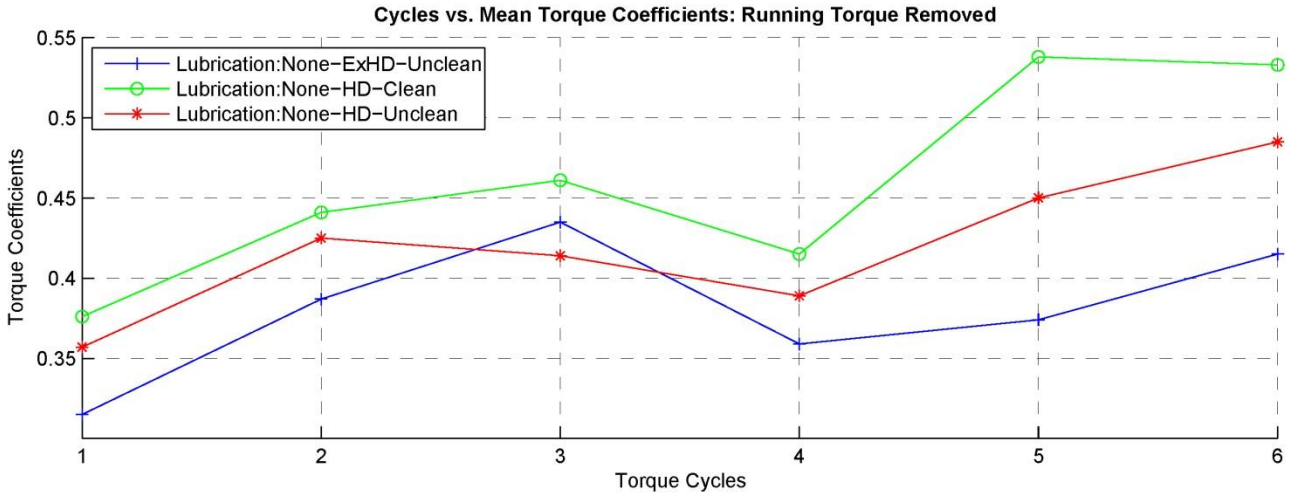
STATISTICAL RESULTS FOR COMBINED CYCLES

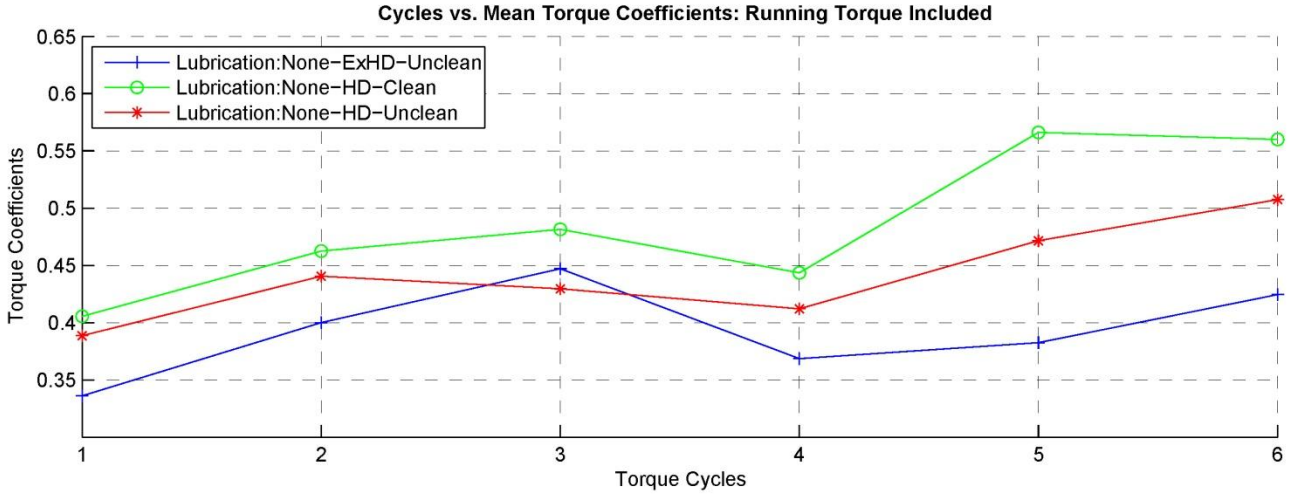
Sum	15.141
Mean	0.421
Median	0.418
Standard Deviation	0.062

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL
(With 95% Confidence for 90% of population)
(N = 36 : 90% = 1.725)

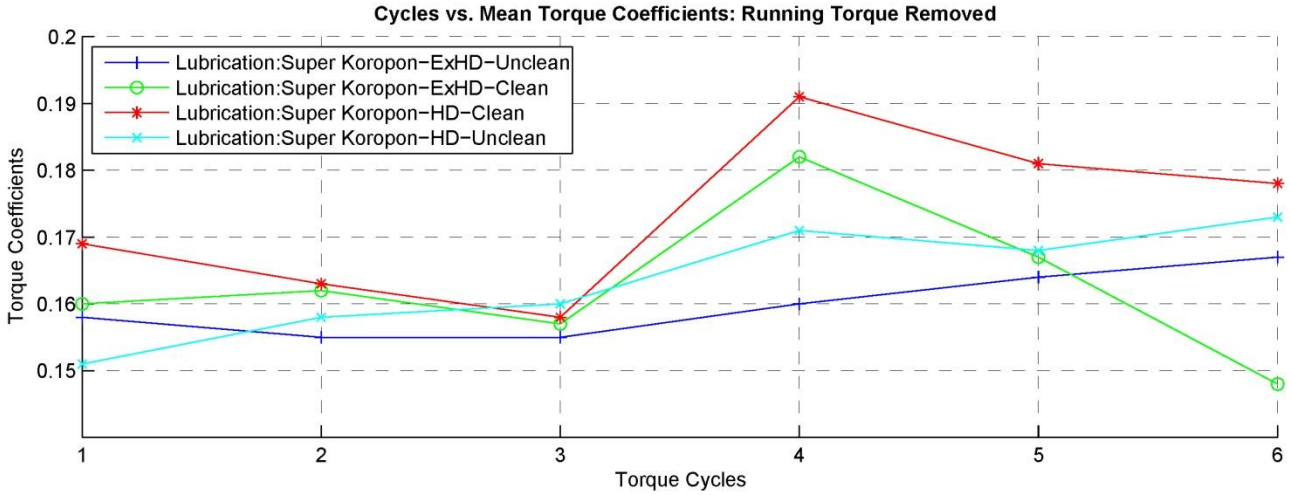
Kmax-90%	0.527405
Kmin-90%	0.313736

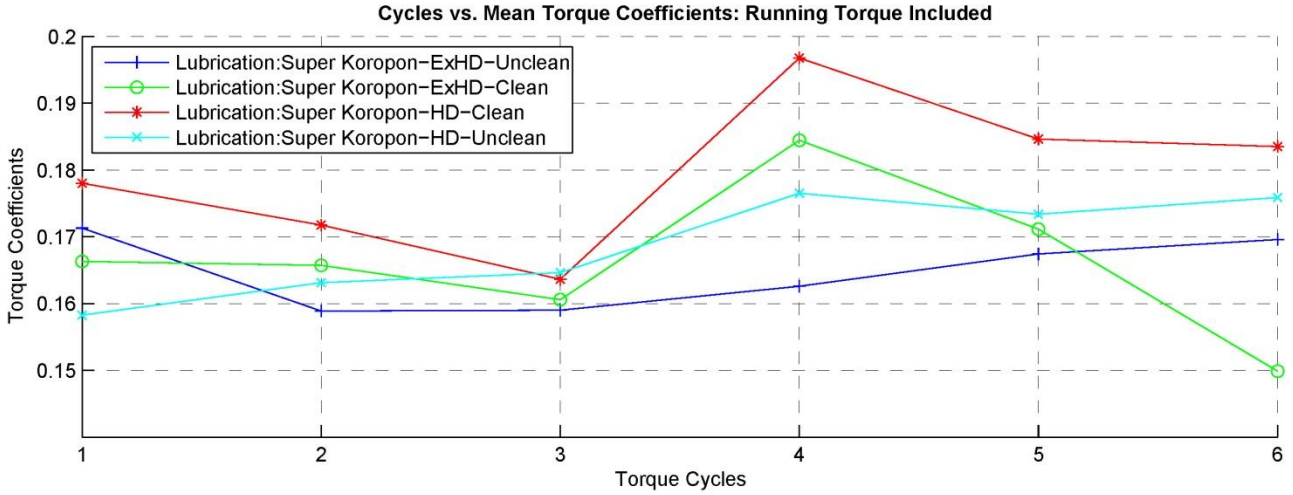
Cycles vs. Mean Torque Coefficients for Various 1/4−28 Locking Keenserts





Cycles vs. Mean Torque Coefficients for Various 1/4−28 Locking Keenserts

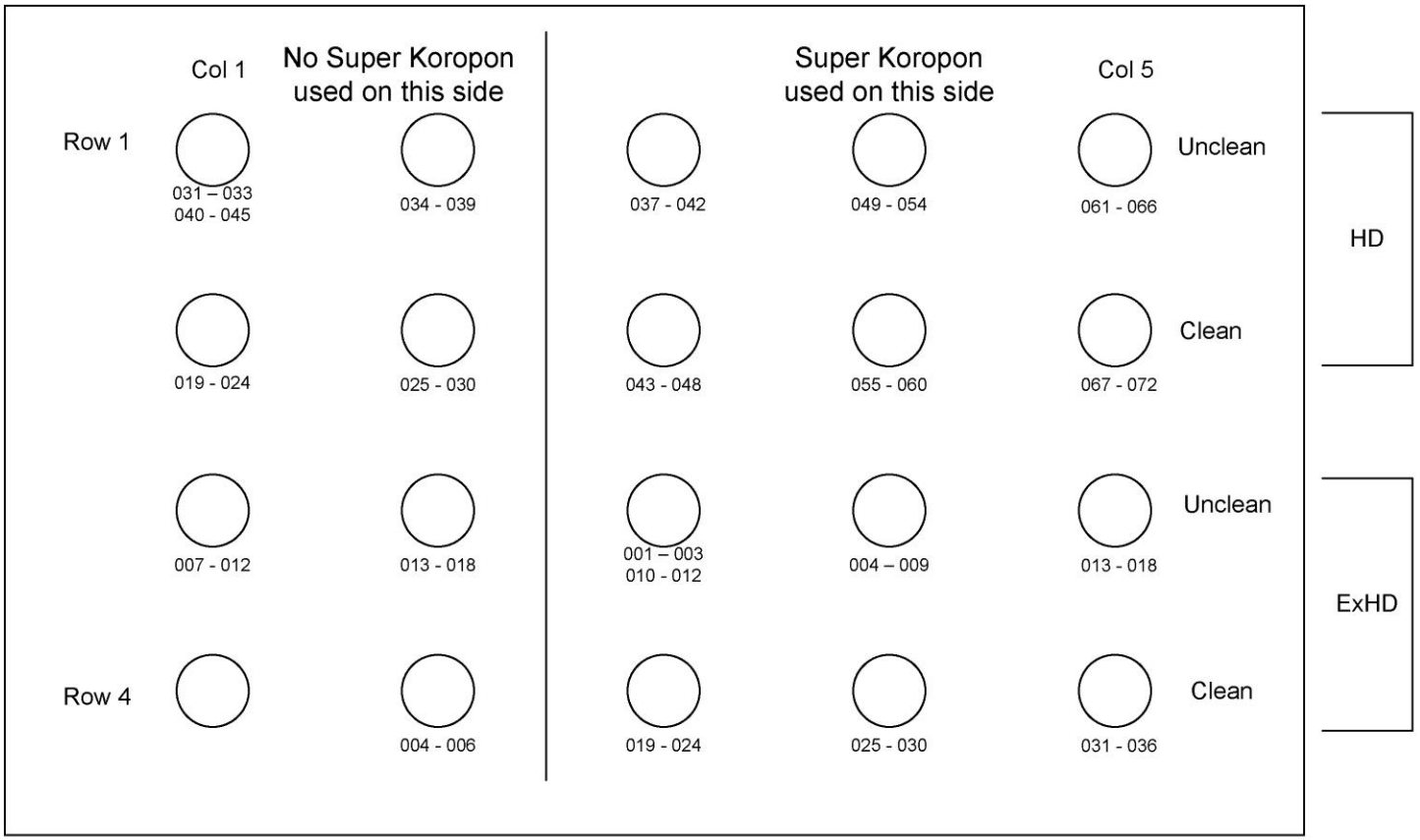




Appendix B:

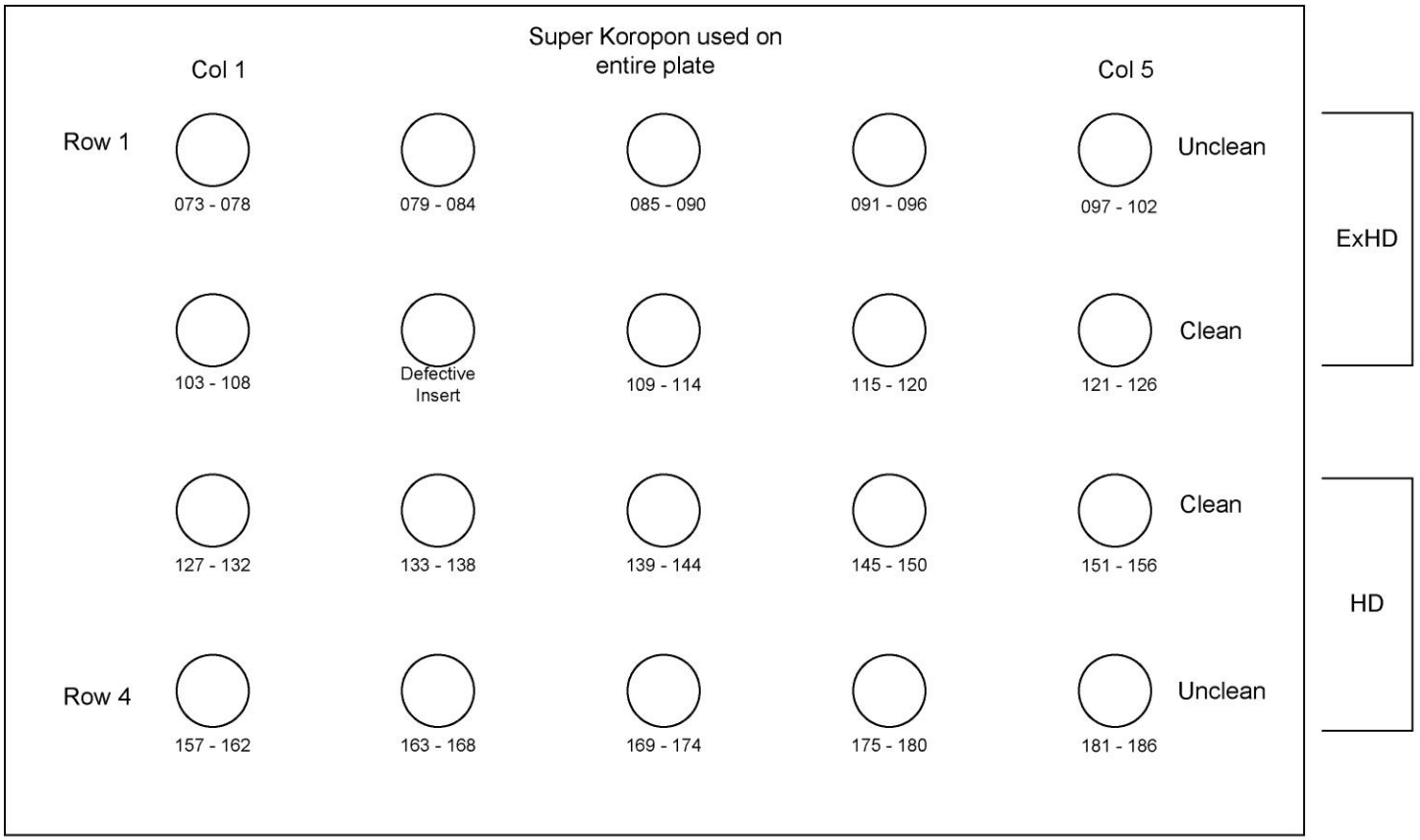
Section 1	¼-28 Dry Torque Tension Plots
Section 2	¼-28 Wet Torque Tension Plots
Section 3	¼-28 Dry Running Torque Plots
Section 4	¼-28 Wet Running Torque Plots
Section 5	¼-28 Dry Cycle Plots: Torque vs. Load
Section 6	¼-28 Wet Cycle Plots: Torque vs. Load
Section 7	¼-28 Friction Coefficients
Section 8	¼-28 Test Plate Layouts
Section 9	¼-28 Dry Run Logs
Section 10	¼-28 Wet Run Logs

¼-28 Fastener Plate No. 1 Layout (Not to scale)



HD = Heavy Duty inserts : MS51831CA202L
ExHD = Light Duty inserts : MS51832CA202L

¼-28 Fastener Plate No. 2 Layout (Not to scale)



HD = Heavy Duty inserts : MS51831CA202L : Lot No. A052308I
ExHD = Light Duty inserts : MS51832CA202L : Lot No. 232019

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Section 5	¼-28 Dry Cycle Plots: Torque vs. Load
Section 6	¼-28 Wet Cycle Plots: Torque vs. Load
Section 7	¼-28 Friction Coefficients
Section 8	¼-28 Test Plate Layouts
Section 9	¼-28 Dry Run Logs
Section 10	¼-28 Wet Run Logs

NESC Orion Torque/Tension Run Log

Date: 8/31/2009
Time: 1:35 PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 4.9, 20.0, 49.9
Temperature(ºF): 71.2
Humidity(%): 55.0

Tor Wrench Op: C. McLeod

Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4 Clean
Washer: LMC21D5AC4C
The torque wrench used is a 600 in-lb torque wrench calibrated out to 300 in-lb

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA202L Dry	Keensert Type HD MS51831CA202L Wet	Keensert Type ExHD MS51832CA202L Dry	Keensert Type ExHD MS51832CA202L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
4	4,2	1	NAS6704U12	1/4-28 x .5	3154	207			X		9644	300 in-lb	
5	4,2	2	NAS6704U12	1/4-28 x .5	3154	253			X		9644	300 in-lb	
6	4,2	3	NAS6704U12	1/4-28 x .5	3154	383			X		9644	300 in-lb	
				Change Bolt									
7	3,1	1	NAS6704U12	1/4-28 x .5	3154	251			X		9644	300 in-lb	
8	3,1	2	NAS6704U12	1/4-28 x .5	3154	297			X		9644	300 in-lb	
9	3,1	3	NAS6704U12	1/4-28 x .5	3154	345			X		9644	300 in-lb	
				Change Bolt									
10	3,1	1	NAS6704U12	1/4-28 x .5	3154	267			X		9644	300 in-lb	
11	3,1	2	NAS6704U12	1/4-28 x .5	3154	301			X		9644	300 in-lb	
12	3,1	3	NAS6704U12	1/4-28 x .5	3154	298			X		9644	300 in-lb	
				Change Bolt									
13	3,2	1	NAS6704U12	1/4-28 x .5	3154	305			X		9644	300 in-lb	
14	3,2	2	NAS6704U12	1/4-28 x .5	3154	331			X		9644	300 in-lb	
15	3,2	3	NAS6704U12	1/4-28 x .5	3154	341			X		9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 8/31/2009
Time: 3:05 PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 4.9, 20.0, 49.9
Temperature(ºF): 71.7
Humidity(%): 54.0

Tor Wrench Op: C. McLeod

Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4 Clean
Washer: LMC21D5AC4C
The torque wrench used is a 600 in-lb torque wrench calibrated out to 300 in-lb

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type				Torq. Wrench		Comments
							HD MS51831CA202L		ExHD MS51832CA202L				
							Dry	Wet	Dry	Wet	S/N	Capacity	
16	3,2	1	NAS6704U12	1/4-28 x .5	3154	304			X		9644	300 in-lb	
17	3,2	2	NAS6704U12	1/4-28 x .5	3154	319			X		9644	300 in-lb	
18	3,2	3	NAS6704U12	1/4-28 x .5	3154	355			X		9644	300 in-lb	
				Change Bolt									
19	2,1	1	NAS6704U12	1/4-28 x .5	3154	310	X				9644	300 in-lb	
20	2,1	2	NAS6704U12	1/4-28 x .5	3154	345	X				9644	300 in-lb	
21	2,1	3	NAS6704U12	1/4-28 x .5	3154	388	X				9644	300 in-lb	
				Change Bolt									
22	2,1	1	NAS6704U12	1/4-28 x .5	3154	343	X				9644	300 in-lb	
23	2,1	2	NAS6704U12	1/4-28 x .5	3154	427	X				9644	300 in-lb	
24	2,1	3	NAS6704U12	1/4-28 x .5	3154	440	X				9644	300 in-lb	
				Change Bolt									
		1	NAS6704U12	1/4-28 x .5	3154						9644	300 in-lb	
		2	NAS6704U12	1/4-28 x .5	3154						9644	300 in-lb	
		3	NAS6704U12	1/4-28 x .5	3154						9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 9/2/2009
Time: 1:41 PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.0, 20.0, 50.3
Temperature(ºF): 70.5
Humidity(%): 56.0

Tor Wrench Op: C. McLeod

Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4 Clean
Washer: LMC21D5AC4C
The torque wrench used is a 600 in-lb torque wrench calibrated out to 300 in-lb

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA202L Dry	HD MS51831CA202L Wet	ExHD MS51832CA202L Dry	ExHD MS51832CA202L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
25	2,2	1	NAS6704U12	1/4-28 x .5	3154	290	X				9644	300 in-lb	
26	2,2	2	NAS6704U12	1/4-28 x .5	3154	331	X				9644	300 in-lb	
27	2,2	3	NAS6704U12	1/4-28 x .5	3154	366	X				9644	300 in-lb	
				Change Bolt									
28	2,2	1	NAS6704U12	1/4-28 x .5	3154	370	X				9644	300 in-lb	47 Data points
29	2,2	2	NAS6704U12	1/4-28 x .5	3154	447	X				9644	300 in-lb	
30	2,2	3	NAS6704U12	1/4-28 x .5	3154	409	X				9644	300 in-lb	
				Change Bolt									
31	1,1	1	NAS6704U12	1/4-28 x .5	3154	262	X				9644	300 in-lb	
32	1,1	2	NAS6704U12	1/4-28 x .5	3154	313	X				9644	300 in-lb	
33	1,1	3	NAS6704U12	1/4-28 x .5	3154	329	X				9644	300 in-lb	
				Change Bolt									
		1	NAS6704U12	1/4-28 x .5	3154		X				9644	300 in-lb	
		2	NAS6704U12	1/4-28 x .5	3154		X				9644	300 in-lb	
		3	NAS6704U12	1/4-28 x .5	3154		X				9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 9/14/2009
Time: 1:55 PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.1, 20.2, 50.1
Temperature(ºF): 71.6
Humidity(%): 55.0

Tor Wrench Op: C. McLeod

Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4 Clean
Washer: LMC21D5AC4C
The torque wrench used is a 600 in-lb torque wrench calibrated out to 300 in-lb

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA202L Dry	HD MS51831CA202L Wet	ExHD MS51832CA202L Dry	ExHD MS51832CA202L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
34	1,2	1	NAS6704U12	1/4-28 x .5	3154	289	X				9644	300 in-lb	
35	1,2	2	NAS6704U12	1/4-28 x .5	3154	288	X				9644	300 in-lb	
36	1,2	3	NAS6704U12	1/4-28 x .5	3154	N/A	X				9644	300 in-lb	
				Change Bolt									
37	1,2	1	NAS6704U12	1/4-28 x .5	3154	256	X				9644	300 in-lb	
38	1,2	2	NAS6704U12	1/4-28 x .5	3154	N/A	X				9644	300 in-lb	
39	1,2	3	NAS6704U12	1/4-28 x .5	3154	306	X				9644	300 in-lb	
				Change Bolt									
40	1,1	1	NAS6704U12	1/4-28 x .5	3154	261	X				9644	300 in-lb	
41	1,1	2	NAS6704U12	1/4-28 x .5	3154	282	X				9644	300 in-lb	
42	1,1	3	NAS6704U12	1/4-28 x .5	3154	308	X				9644	300 in-lb	
				Change Bolt									
43	1,1	1	NAS6704U12	1/4-28 x .5	3154	N/A	X				9644	300 in-lb	
44	1,1	2	NAS6704U12	1/4-28 x .5	3154	311	X				9644	300 in-lb	
45	1,1	3	NAS6704U12	1/4-28 x .5	3154	326	X				9644	300 in-lb	
				Change Bolt									

Appendix B:

Section 1	¼-28 Dry Torque Tension Plots
Section 2	¼-28 Wet Torque Tension Plots
Section 3	¼-28 Dry Running Torque Plots
Section 4	¼-28 Wet Running Torque Plots
Section 5	¼-28 Dry Cycle Plots: Torque vs. Load
Section 6	¼-28 Wet Cycle Plots: Torque vs. Load
Section 7	¼-28 Friction Coefficients
Section 8	¼-28 Test Plate Layouts
Section 9	¼-28 Dry Run Logs
Section 10	¼-28 Wet Run Logs

NESC Orion Torque/Tension Run Log

Date: 10/27/2009
Time: 9:50 AM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.05, 20.0, 49.95
Temperature(ºF): 71.7
Humidity(%): 56.0

Tor Wrench Op: Kevin Hagerich
Data Sys. Op: Wayne Goodman
Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4 Clean
Washer: LMC21D5AC4C
The torque wrench used is a 600 in-lb torque wrench
calibrated out to 300 in-lb
Super Koropon used

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type				Torq. Wrench		Comments
							HD MS51831CA202L		ExHD MS51832CA202L				
							Dry	Wet	Dry	Wet	S/N	Capacity	
1	3,3	1	NAS6704U12	1/4-28 x .5	3154	61				X	9644	300 in-lb	
2	3,3	2	NAS6704U12	1/4-28 x .5	3154	104				X	9644	300 in-lb	
3	3,3	3	NAS6704U12	1/4-28 x .5	3154	105				X	9644	300 in-lb	
				Change Bolt									
4	3,4	1	NAS6704U12	1/4-28 x .5	3154	102				X	9644	300 in-lb	
5	3,4	2	NAS6704U12	1/4-28 x .5	3154	113				X	9644	300 in-lb	
6	3,4	3	NAS6704U12	1/4-28 x .5	3154	109				X	9644	300 in-lb	
				Change Bolt									
		1	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
		2	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
		3	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
				Change Bolt									
		1	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
		2	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
		3	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 10/28/2009
Time: 1:15 PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.05, 19.9, 49.7
Temperature(ºF): 71.0
Humidity(%): 53.0

Tor Wrench Op: Kevin Hagerich
Data Sys. Op: Wayne Goodman
Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4 Clean
Washer: LMC21D5AC4C
The torque wrench used is a 600 in-lb torque wrench
calibrated out to 300 in-lb
Super Koropon used

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA202L Dry	Keensert Type HD MS51831CA202L Wet	Keensert Type ExHD MS51832CA202L Dry	Keensert Type ExHD MS51832CA202L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
7	3,4	1	NAS6704U12	1/4-28 x .5	3154	88				X	9644	300 in-lb	
8	3,4	2	NAS6704U12	1/4-28 x .5	3154	87				X	9644	300 in-lb	
9	3,4	3	NAS6704U12	1/4-28 x .5	3154	89				X	9644	300 in-lb	
				Change Bolt									
10	3,3	1	NAS6704U12	1/4-28 x .5	3154	88				X	9644	300 in-lb	
11	3,3	2	NAS6704U12	1/4-28 x .5	3154	85				X	9644	300 in-lb	
12	3,3	3	NAS6704U12	1/4-28 x .5	3154	89				X	9644	300 in-lb	
				Change Bolt									
13	3,5	1	NAS6704U12	1/4-28 x .5	3154	111				X	9644	300 in-lb	
14	3,5	2	NAS6704U12	1/4-28 x .5	3154	95				X	9644	300 in-lb	
15	3,5	3	NAS6704U12	1/4-28 x .5	3154	109				X	9644	300 in-lb	
				Change Bolt									
16	3,5	1	NAS6704U12	1/4-28 x .5	3154	99				X	9644	300 in-lb	
17	3,5	2	NAS6704U12	1/4-28 x .5	3154	92				X	9644	300 in-lb	
18	3,5	3	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 10/28/2009
Time: 2:10 PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.05, 19.9, 49.7
Temperature(ºF): 71.0
Humidity(%): 53.0

Tor Wrench Op: Kevin Hagerich
Data Sys. Op: Wayne Goodman
Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4 Clean
Washer: LMC21D5AC4C
The torque wrench used is a 600 in-lb torque wrench
calibrated out to 300 in-lb
Super Koropon used

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type				Torq. Wrench		Comments
							HD MS51831CA202L		ExHD MS51832CA202L				
							Dry	Wet	Dry	Wet	S/N	Capacity	
19	4,3	1	NAS6704U12	1/4-28 x .5	3154	125				X	9644	300 in-lb	
20	4,3	2	NAS6704U12	1/4-28 x .5	3154	108				X	9644	300 in-lb	
21	4,3	3	NAS6704U12	1/4-28 x .5	3154	89				X	9644	300 in-lb	
				Change Bolt									
		1	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
		2	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
		3	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
				Change Bolt									
		1	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
		2	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
		3	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
				Change Bolt									
		1	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
		2	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
		3	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 10/30/2009
Time: 7:45 AM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.0, 20.0, 49.9
Temperature(ºF): 71.0
Humidity(%): 50.0

Tor Wrench Op: Kevin Hagerich
Data Sys. Op: Wayne Goodman
Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4 Clean
Washer: LMC21D5AC4C
The torque wrench used is a 600 in-lb torque wrench
calibrated out to 300 in-lb
Super Koropon used

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type				Torq. Wrench		Comments
							HD MS51831CA202L		ExHD MS51832CA202L				
							Dry	Wet	Dry	Wet	S/N	Capacity	
22	4,3	1	NAS6704U12	1/4-28 x .5	3154	127				X	9644	300 in-lb	
23	4,3	2	NAS6704U12	1/4-28 x .5	3154	116				X	9644	300 in-lb	
24	4,3	3	NAS6704U12	1/4-28 x .5	3154	115				X	9644	300 in-lb	
				Change Bolt									
25	4,4	1	NAS6704U12	1/4-28 x .5	3154	95				X	9644	300 in-lb	
26	4,4	2	NAS6704U12	1/4-28 x .5	3154	114				X	9644	300 in-lb	
27	4,4	3	NAS6704U12	1/4-28 x .5	3154	120				X	9644	300 in-lb	
				Change Bolt									
28	4,4	1	NAS6704U12	1/4-28 x .5	3154	118				X	9644	300 in-lb	
29	4,4	2	NAS6704U12	1/4-28 x .5	3154	111				X	9644	300 in-lb	
30	4,4	3	NAS6704U12	1/4-28 x .5	3154	116				X	9644	300 in-lb	
				Change Bolt									
		1	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
		2	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
		3	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 10/30/2009
Time: 8:40 AM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.0, 20.0, 49.9
Temperature(ºF): 71.7
Humidity(%): 48.0

Tor Wrench Op: Kevin Hagerich
Data Sys. Op: Wayne Goodman
Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4 Clean
Washer: LMC21D5AC4C
The torque wrench used is a 600 in-lb torque wrench
calibrated out to 300 in-lb
Super Koropon used

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA202L Dry	Keensert Type HD MS51831CA202L Wet	Keensert Type ExHD MS51832CA202L Dry	Keensert Type ExHD MS51832CA202L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
31	4,5	1	NAS6704U12	1/4-28 x .5	3154	101				X	9644	300 in-lb	
32	4,5	2	NAS6704U12	1/4-28 x .5	3154	108				X	9644	300 in-lb	
33	4,5	3	NAS6704U12	1/4-28 x .5	3154	104				X	9644	300 in-lb	
				Change Bolt									
34	4,5	1	NAS6704U12	1/4-28 x .5	3154	102				X	9644	300 in-lb	Glitch not operator err
35	4,5	2	NAS6704U12	1/4-28 x .5	3154	89				X	9644	300 in-lb	
36	4,5	3	NAS6704U12	1/4-28 x .5	3154	84				X	9644	300 in-lb	
				Change Bolt									
		1	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
		2	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
		3	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
				Change Bolt									
		1	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
		2	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
		3	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 10/30/2009
Time: 9:30 AM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.0, 20.0, 49.9
Temperature(ºF): 71.6
Humidity(%): 48.0

Tor Wrench Op: Kevin Hagerich
Data Sys. Op: Wayne Goodman
Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4 Clean
Washer: LMC21D5AC4C
The torque wrench used is a 600 in-lb torque wrench
calibrated out to 300 in-lb
Super Koropon used

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type				Torq. Wrench		Comments
							HD MS51831CA202L		ExHD MS51832CA202L				
							Dry	Wet	Dry	Wet	S/N	Capacity	
37	1,3	1	NAS6704U12	1/4-28 x .5	3154	102		X			9644	300 in-lb	
38	1,3	2	NAS6704U12	1/4-28 x .5	3154	114		X			9644	300 in-lb	
39	1,3	3	NAS6704U12	1/4-28 x .5	3154	100		X			9644	300 in-lb	
				Change Bolt									
40	1,3	1	NAS6704U12	1/4-28 x .5	3154	120		X			9644	300 in-lb	
41	1,3	2	NAS6704U12	1/4-28 x .5	3154	112		X			9644	300 in-lb	
42	1,3	3	NAS6704U12	1/4-28 x .5	3154	109		X			9644	300 in-lb	
				Change Bolt									
43	2,3	1	NAS6704U12	1/4-28 x .5	3154	119		X			9644	300 in-lb	
44	2,3	2	NAS6704U12	1/4-28 x .5	3154	101		X			9644	300 in-lb	
45	2,3	3	NAS6704U12	1/4-28 x .5	3154	98		X			9644	300 in-lb	
				Change Bolt									
46	2,3	1	NAS6704U12	1/4-28 x .5	3154	124		X			9644	300 in-lb	
47	2,3	2	NAS6704U12	1/4-28 x .5	3154	100		X			9644	300 in-lb	
48	2,3	3	NAS6704U12	1/4-28 x .5	3154	96		X			9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 10/30/2009
Time: 10:38 AM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.0, 20.0, 49.9
Temperature(ºF): 71.6
Humidity(%): 47.0

Tor Wrench Op: Kevin Hagerich
Data Sys. Op: Wayne Goodman
Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4 Clean
Washer: LMC21D5AC4C
The torque wrench used is a 600 in-lb torque wrench
calibrated out to 300 in-lb
Super Koropon used

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA202L		Keensert Type ExHD MS51832CA202L		Torq. Wrench		Comments
							Dry	Wet	Dry	Wet	S/N	Capacity	
49	1,4	1	NAS6704U12	1/4-28 x .5	3154	110		X			9644	300 in-lb	
50	1,4	2	NAS6704U12	1/4-28 x .5	3154	93		X			9644	300 in-lb	
51	1,4	3	NAS6704U12	1/4-28 x .5	3154	101		X			9644	300 in-lb	
				Change Bolt									
52	1,4	1	NAS6704U12	1/4-28 x .5	3154	127		X			9644	300 in-lb	Glitch not operator err
53	1,4	2	NAS6704U12	1/4-28 x .5	3154	110		X			9644	300 in-lb	
54	1,4	3	NAS6704U12	1/4-28 x .5	3154	140		X			9644	300 in-lb	
				Change Bolt									
55	2,4	1	NAS6704U12	1/4-28 x .5	3154	118		X			9644	300 in-lb	Glitch not operator err
56	2,4	2	NAS6704U12	1/4-28 x .5	3154	140		X			9644	300 in-lb	
57	2,4	3	NAS6704U12	1/4-28 x .5	3154	130		X			9644	300 in-lb	
				Change Bolt									
58	2,4	1	NAS6704U12	1/4-28 x .5	3154	140		X			9644	300 in-lb	
59	2,4	2	NAS6704U12	1/4-28 x .5	3154	140		X			9644	300 in-lb	
60	2,4	3	NAS6704U12	1/4-28 x .5	3154	136		X			9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 10/30/2009
Time: 1:20 PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.0, 20.0, 49.9
Temperature(ºF): 71.6
Humidity(%): 48.0

Tor Wrench Op: Kevin Hagerich
Data Sys. Op: Walt P.
Notes:
Test plate Rows 1 & 3 Dirty; Rows 2 & 4 Clean
Washer: LMC21D5AC4C
The torque wrench used is a 600 in-lb torque wrench
calibrated out to 300 in-lb
Super Koropon used

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type				Torq. Wrench		Comments
							HD MS51831CA202L		ExHD MS51832CA202L				
							Dry	Wet	Dry	Wet	S/N	Capacity	
61	1,5	1	NAS6704U12	1/4-28 x .5	3154	108		X			9644	300 in-lb	
62	1,5	2	NAS6704U12	1/4-28 x .5	3154	132		X			9644	300 in-lb	
63	1,5	3	NAS6704U12	1/4-28 x .5	3154	120		X			9644	300 in-lb	
				Change Bolt									
64	1,5	1	NAS6704U12	1/4-28 x .5	3154	114		X			9644	300 in-lb	
65	1,5	2	NAS6704U12	1/4-28 x .5	3154	118		X			9644	300 in-lb	
66	1,5	3	NAS6704U12	1/4-28 x .5	3154	132		X			9644	300 in-lb	
				Change Bolt									
67	2,5	1	NAS6704U12	1/4-28 x .5	3154	128		X			9644	300 in-lb	
68	2,5	2	NAS6704U12	1/4-28 x .5	3154	133		X			9644	300 in-lb	
69	2,5	3	NAS6704U12	1/4-28 x .5	3154	107		X			9644	300 in-lb	
				Change Bolt									
70	2,5	1	NAS6704U12	1/4-28 x .5	3154	138		X			9644	300 in-lb	
71	2,5	2	NAS6704U12	1/4-28 x .5	3154	129		X			9644	300 in-lb	
72	2,5	3	NAS6704U12	1/4-28 x .5	3154	139		X			9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 11/20/2009
Time:
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb):
Temperature(ºF):
Humidity(%):

Tor Wrench Op: Kevin Hagerich
Data Sys. Op: Wayne Goodman
Notes:
Test plate Rows 1 & 4 Dirty; Rows 2 & 3 Clean
Washer: LMC21D5AC4C
The torque wrench used is a 600 in-lb torque wrench
calibrated out to 300 in-lb
Super Koropon used

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA202L Dry	Keensert Type HD MS51831CA202L Wet	Keensert Type ExHD MS51832CA202L Dry	Keensert Type ExHD MS51832CA202L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
73	1,1	1	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
74	1,1	2	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
75	1,1	3	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
				Change Bolt									
76	1,1	1	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
77	1,1	2	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
78	1,1	3	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
				Change Bolt									
79	1,2	1	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
80	1,2	2	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
81	1,2	3	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
				Change Bolt									
82	1,2	1	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
83	1,2	2	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
84	1,2	3	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 11/20/2009
Time:
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb):
Temperature(ºF):
Humidity(%):

Tor Wrench Op: Kevin Hagerich
Data Sys. Op: Wayne Goodman
Notes:
Test plate Rows 1 & 4 Dirty; Rows 2 & 3 Clean
Washer: LMC21D5AC4C
The torque wrench used is a 600 in-lb torque wrench
calibrated out to 300 in-lb
Super Koropon used

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA202L Dry	Keensert Type HD MS51831CA202L Wet	Keensert Type ExHD MS51832CA202L Dry	Keensert Type ExHD MS51832CA202L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
85	1,3	1	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
86	1,3	2	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
87	1,3	3	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
				Change Bolt									
88	1,3	1	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
89	1,3	2	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
90	1,3	3	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
				Change Bolt									
91	1,4	1	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
92	1,4	2	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
93	1,4	3	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
				Change Bolt									
94	1,4	1	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
95	1,4	2	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
96	1,4	3	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 11/20/2009
Time:
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb):
Temperature(ºF):
Humidity(%):

Tor Wrench Op: Kevin Hagerich
Data Sys. Op: Wayne Goodman
Notes:
Test plate Rows 1 & 4 Dirty; Rows 2 & 3 Clean
Washer: LMC21D5AC4C
The torque wrench used is a 600 in-lb torque wrench
calibrated out to 300 in-lb
Super Koropon used

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA202L Dry	Keensert Type HD MS51831CA202L Wet	Keensert Type ExHD MS51832CA202L Dry	Keensert Type ExHD MS51832CA202L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
97	1,5	1	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
98	1,5	2	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
99	1,5	3	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
				Change Bolt									
100	1,5	1	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
101	1,5	2	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
102	1,5	3	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
				Change Bolt									
103	2,1	1	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
104	2,1	2	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
105	2,1	3	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
	2,1			Change Bolt									
106	2,1	1	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
107	2,1	2	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
108	2,1	3	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 11/20/2009
Time:
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb):
Temperature(ºF):
Humidity(%):

Tor Wrench Op: Kevin Hagerich
Data Sys. Op: Wayne Goodman
Notes:
Test plate Rows 1 & 4 Dirty; Rows 2 & 3 Clean
Washer: LMC21D5AC4C
The torque wrench used is a 600 in-lb torque wrench
calibrated out to 300 in-lb
Super Koropon used

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA202L Dry	Keensert Type HD MS51831CA202L Wet	Keensert Type ExHD MS51832CA202L Dry	Keensert Type ExHD MS51832CA202L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
109	2,3	1	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
110	2,3	2	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
111	2,3	3	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
				Change Bolt									
112	2,3	1	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
113	2,3	2	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
114	2,3	3	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
				Change Bolt									
115	2,4	1	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
116	2,4	2	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
117	2,4	3	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
				Change Bolt									
118	2,4	1	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
119	2,4	2	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
120	2,4	3	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 11/20/2009
Time:
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb):
Temperature(ºF):
Humidity(%):

Tor Wrench Op: Kevin Hagerich
Data Sys. Op: Wayne Goodman
Notes:
Test plate Rows 1 & 4 Dirty; Rows 2 & 3 Clean
Washer: LMC21D5AC4C
The torque wrench used is a 600 in-lb torque wrench
calibrated out to 300 in-lb
Super Koropon used

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA202L Dry	Keensert Type HD MS51831CA202L Wet	Keensert Type ExHD MS51832CA202L Dry	Keensert Type ExHD MS51832CA202L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
121	2,5	1	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
122	2,5	2	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
123	2,5	3	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
				Change Bolt									
124	2,5	1	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
125	2,5	2	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
126	2,5	3	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
				Change Bolt									
		1	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
		2	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
		3	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
				Change Bolt									
		1	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
		2	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
		3	NAS6704U12	1/4-28 x .5	3154					X	9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 11/23/2009
Time: 8:05 AM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 4.9, 19.9, 49.9
Temperature(ºF): 70.3
Humidity(%): 46.0

Tor Wrench Op: Kevin Hagerich
Data Sys. Op: Wayne Goodman
Notes:
Test plate Rows 1 & 4 Dirty; Rows 2 & 3Clean
Washer: LMC21D5AC4C
The torque wrench used is a 600 in-lb torque wrench
calibrated out to 300 in-lb
Super Koropon used

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA202L Dry	Keensert Type HD MS51831CA202L Wet	Keensert Type ExHD MS51832CA202L Dry	Keensert Type ExHD MS51832CA202L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
127	3,1	1	NAS6704U12	1/4-28 x .5	3154	102		X			9644	300 in-lb	
128	3,1	2	NAS6704U12	1/4-28 x .5	3154	102		X			9644	300 in-lb	
129	3,1	3	NAS6704U12	1/4-28 x .5	3154	95		X			9644	300 in-lb	
				Change Bolt									
130	3,1	1	NAS6704U12	1/4-28 x .5	3154	103		X			9644	300 in-lb	
131	3,1	2	NAS6704U12	1/4-28 x .5	3154	99		X			9644	300 in-lb	
132	3,1	3	NAS6704U12	1/4-28 x .5	3154	88		X			9644	300 in-lb	
				Change Bolt									
133	3,2	1	NAS6704U12	1/4-28 x .5	3154	109		X			9644	300 in-lb	
134	3,2	2	NAS6704U12	1/4-28 x .5	3154	121		X			9644	300 in-lb	
135	3,2	3	NAS6704U12	1/4-28 x .5	3154	127		X			9644	300 in-lb	
				Change Bolt									
136	3,2	1	NAS6704U12	1/4-28 x .5	3154	157		X			9644	300 in-lb	
137	3,2	2	NAS6704U12	1/4-28 x .5	3154	156		X			9644	300 in-lb	
138	3,2	3	NAS6704U12	1/4-28 x .5	3154	155		X			9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 11/23/2009
Time: 10:35 AM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 4.9, 19.9, 49.9
Temperature(ºF): 70.8
Humidity(%): 46.0

Tor Wrench Op: Kevin Hagerich
Data Sys. Op: Wayne Goodman
Notes:
Test plate Rows 1 & 4 Dirty; Rows 2 & 3Clean
Washer: LMC21D5AC4C
The torque wrench used is a 600 in-lb torque wrench
calibrated out to 300 in-lb
Super Koropon used

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA202L		Keensert Type ExHD MS51832CA202L		Torq. Wrench		Comments
							Dry	Wet	Dry	Wet	S/N	Capacity	
139	3,3	1	NAS6704U12	1/4-28 x .5	3154	114		X			9644	300 in-lb	
140	3,3	2	NAS6704U12	1/4-28 x .5	3154	106		X			9644	300 in-lb	
141	3,3	3	NAS6704U12	1/4-28 x .5	3154	96		X			9644	300 in-lb	
				Change Bolt									
142	3,3	1	NAS6704U12	1/4-28 x .5	3154	121		X			9644	300 in-lb	
143	3,3	2	NAS6704U12	1/4-28 x .5	3154	133		X			9644	300 in-lb	
144	3,3	3	NAS6704U12	1/4-28 x .5	3154	143		X			9644	300 in-lb	
				Change Bolt									
145	3,4	1	NAS6704U12	1/4-28 x .5	3154	99		X			9644	300 in-lb	Slip - Bushing tight
146	3,4	2	NAS6704U12	1/4-28 x .5	3154	107		X			9644	300 in-lb	
147	3,4	3	NAS6704U12	1/4-28 x .5	3154	100		X			9644	300 in-lb	
				Change Bolt									
148	3,4	1	NAS6704U12	1/4-28 x .5	3154	136		X			9644	300 in-lb	Slip - Bushing tight
149	3,4	2	NAS6704U12	1/4-28 x .5	3154	116		X			9644	300 in-lb	
150	3,4	3	NAS6704U12	1/4-28 x .5	3154	121		X			9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 11/23/2009
Time: 11:05 AM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 4.9, 19.9, 49.9
Temperature(ºF): 71.2
Humidity(%): 45.0

Tor Wrench Op: Kevin Hagerich
Data Sys. Op: Wayne Goodman
Notes:
Test plate Rows 1 & 4 Dirty; Rows 2 & 3Clean
Washer: LMC21D5AC4C
The torque wrench used is a 600 in-lb torque wrench calibrated out to 300 in-lb
Super Koropon used

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA202L Dry	Keensert Type HD MS51831CA202L Wet	Keensert Type ExHD MS51832CA202L Dry	Keensert Type ExHD MS51832CA202L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
151	3,5	1	NAS6704U12	1/4-28 x .5	3154	120		X			9644	300 in-lb	Slip - Bushing tight
152	3,5	2	NAS6704U12	1/4-28 x .5	3154	126		X			9644	300 in-lb	
153	3,5	3	NAS6704U12	1/4-28 x .5	3154	108		X			9644	300 in-lb	
				Change Bolt									
154	3,5	1	NAS6704U12	1/4-28 x .5	3154	128		X			9644	300 in-lb	
155	3,5	2	NAS6704U12	1/4-28 x .5	3154	127		X			9644	300 in-lb	
156	3,5	3	NAS6704U12	1/4-28 x .5	3154	118		X			9644	300 in-lb	
				Change Bolt									
		1	NAS6704U12	1/4-28 x .5	3154			X			9644	300 in-lb	
		2	NAS6704U12	1/4-28 x .5	3154			X			9644	300 in-lb	
		3	NAS6704U12	1/4-28 x .5	3154			X			9644	300 in-lb	
				Change Bolt									
		1	NAS6704U12	1/4-28 x .5	3154			X			9644	300 in-lb	
		2	NAS6704U12	1/4-28 x .5	3154			X			9644	300 in-lb	
		3	NAS6704U12	1/4-28 x .5	3154			X			9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 12/1/2009
Time: 1:30 PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.0, 20.0, 50.0
Temperature(ºF): 70.8
Humidity(%): 39.0

Tor Wrench Op: Walt P.
Data Sys. Op: Wayne Goodman
Notes:
Test plate Rows 1 & 4 Dirty; Rows 2 & 3Clean
Washer: LMC21D5AC4C
The torque wrench used is a 600 in-lb torque wrench calibrated out to 300 in-lb
Super Koropon used

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA202L Dry	Keensert Type HD MS51831CA202L Wet	Keensert Type ExHD MS51832CA202L Dry	Keensert Type ExHD MS51832CA202L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
157	4,1	1	NAS6704U12	1/4-28 x .5	3154	106		X			9644	300 in-lb	
158	4,1	2	NAS6704U12	1/4-28 x .5	3154	117		X			9644	300 in-lb	
159	4,1	3	NAS6704U12	1/4-28 x .5	3154	120		X			9644	300 in-lb	
				Change Bolt									
160	4,1	1	NAS6704U12	1/4-28 x .5	3154	104		X			9644	300 in-lb	
161	4,1	2	NAS6704U12	1/4-28 x .5	3154	105		X			9644	300 in-lb	
162	4,1	3	NAS6704U12	1/4-28 x .5	3154	104		X			9644	300 in-lb	
				Change Bolt									
163	4,2	1	NAS6704U12	1/4-28 x .5	3154	94		X			9644	300 in-lb	
164	4,2	2	NAS6704U12	1/4-28 x .5	3154	93		X			9644	300 in-lb	
165	4,2	3	NAS6704U12	1/4-28 x .5	3154	121		X			9644	300 in-lb	
166	4,2	4	NAS6704U12	1/4-28 x .5	3154	N/A		X			9644	300 in-lb	4th cycle for this bolt
				Change Bolt									
167	4,2	1	NAS6704U12	1/4-28 x .5	3154	132		X			9644	300 in-lb	
168	4,2	2	NAS6704U12	1/4-28 x .5	3154	112		X			9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 12/1/2009
Time: 2:40 PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.0, 20.0, 50.0
Temperature(ºF): 71.4
Humidity(%): 38.0

Tor Wrench Op: Walt P.
Data Sys. Op: Wayne Goodman
Notes:
Test plate Rows 1 & 4 Dirty; Rows 2 & 3Clean
Washer: LMC21D5AC4C
The torque wrench used is a 600 in-lb torque wrench calibrated out to 300 in-lb
Super Koropon used

Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA202L Dry	Keensert Type HD MS51831CA202L Wet	Keensert Type ExHD MS51832CA202L Dry	Keensert Type ExHD MS51832CA202L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
169	4,3	1	NAS6704U12	1/4-28 x .5	3154	101		X			9644	300 in-lb	
170	4,3	2	NAS6704U12	1/4-28 x .5	3154	107		X			9644	300 in-lb	
171	4,3	3	NAS6704U12	1/4-28 x .5	3154	107		X			9644	300 in-lb	
				Change Bolt									
172	4,3	1	NAS6704U12	1/4-28 x .5	3154	105		X			9644	300 in-lb	
173	4,3	2	NAS6704U12	1/4-28 x .5	3154	94		X			9644	300 in-lb	
174	4,3	3	NAS6704U12	1/4-28 x .5	3154	102		X			9644	300 in-lb	
				Change Bolt									
175	4,4	1	NAS6704U12	1/4-28 x .5	3154	91		X			9644	300 in-lb	
176	4,4	2	NAS6704U12	1/4-28 x .5	3154	96		X			9644	300 in-lb	
177	4,4	3	NAS6704U12	1/4-28 x .5	3154	79		X			9644	300 in-lb	
		4	NAS6704U12	1/4-28 x .5	3154			X			9644	300 in-lb	
178	4,4			Change Bolt		109							
179	4,4	1	NAS6704U12	1/4-28 x .5	3154	125		X			9644	300 in-lb	
180	4,4	2	NAS6704U12	1/4-28 x .5	3154	113		X			9644	300 in-lb	
				Change Bolt									

NESC Orion Torque/Tension Run Log

Date: 12/1/2009
Time: 3:25 PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.0, 20.0, 50.0
Temperature(ºF): 71.0
Humidity(%): 38.0

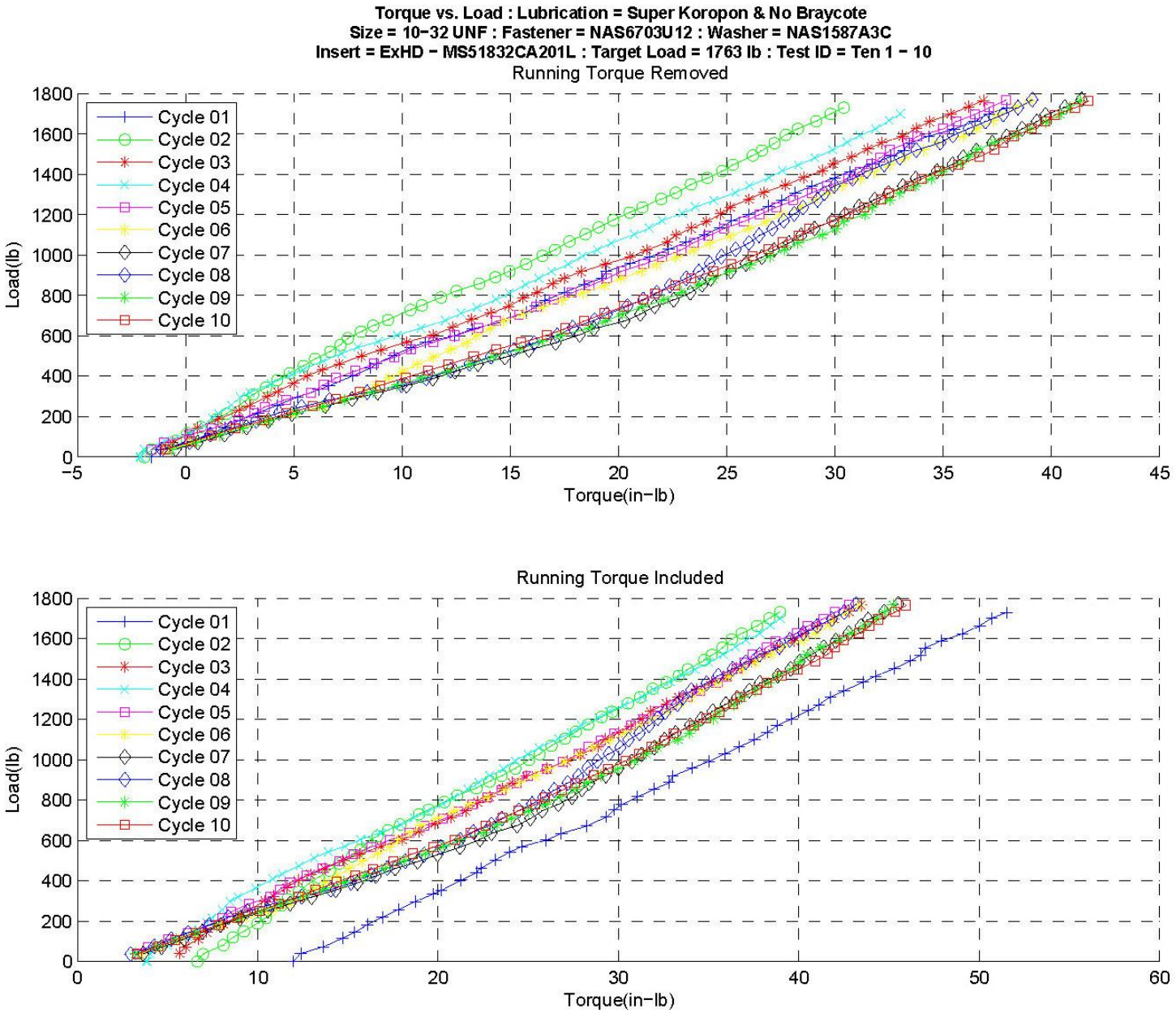
Tor Wrench Op: Walt P.
Data Sys. Op: Wayne Goodman
Notes:
Test plate Rows 1 & 4 Dirty; Rows 2 & 3Clean
Washer: LMC21D5AC4C
The torque wrench used is a 600 in-lb torque wrench
calibrated out to 300 in-lb
Super Koropon used

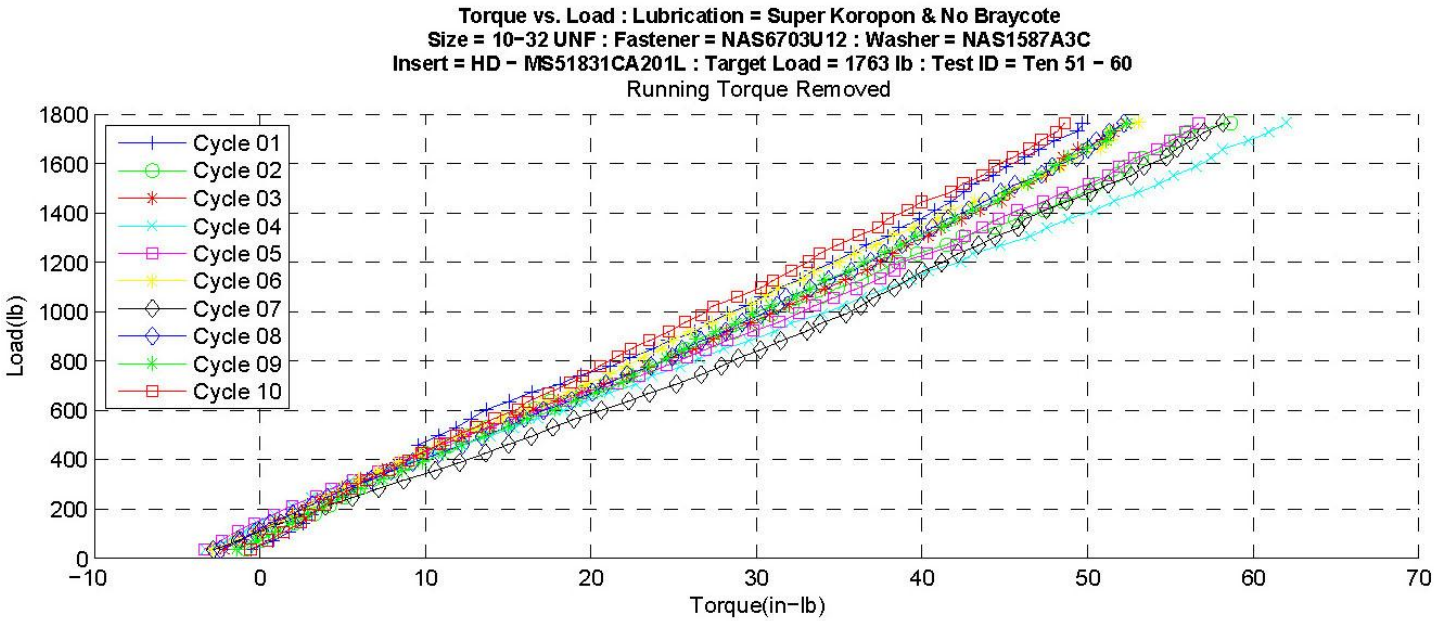
Run No.	Cord	Cycle No.	Fastener	Fastener Size	Target Load (lb)	Brk Torq (in-lb)	Keensert Type HD MS51831CA202L Dry	Keensert Type HD MS51831CA202L Wet	Keensert Type ExHD MS51832CA202L Dry	Keensert Type ExHD MS51832CA202L Wet	Torq. Wrench S/N	Torq. Wrench Capacity	Comments
181	4,5	1	NAS6704U12	1/4-28 x .5	3154	99		X			9644	300 in-lb	
182	4,5	2	NAS6704U12	1/4-28 x .5	3154	106		X			9644	300 in-lb	
183	4,5	3	NAS6704U12	1/4-28 x .5	3154	89		X			9644	300 in-lb	
				Change Bolt									
184	4,5	1	NAS6704U12	1/4-28 x .5	3154	126		X			9644	300 in-lb	
185	4,5	2	NAS6704U12	1/4-28 x .5	3154	137		X			9644	300 in-lb	
186	4,5	3	NAS6704U12	1/4-28 x .5	3154	123		X			9644	300 in-lb	
				Change Bolt									

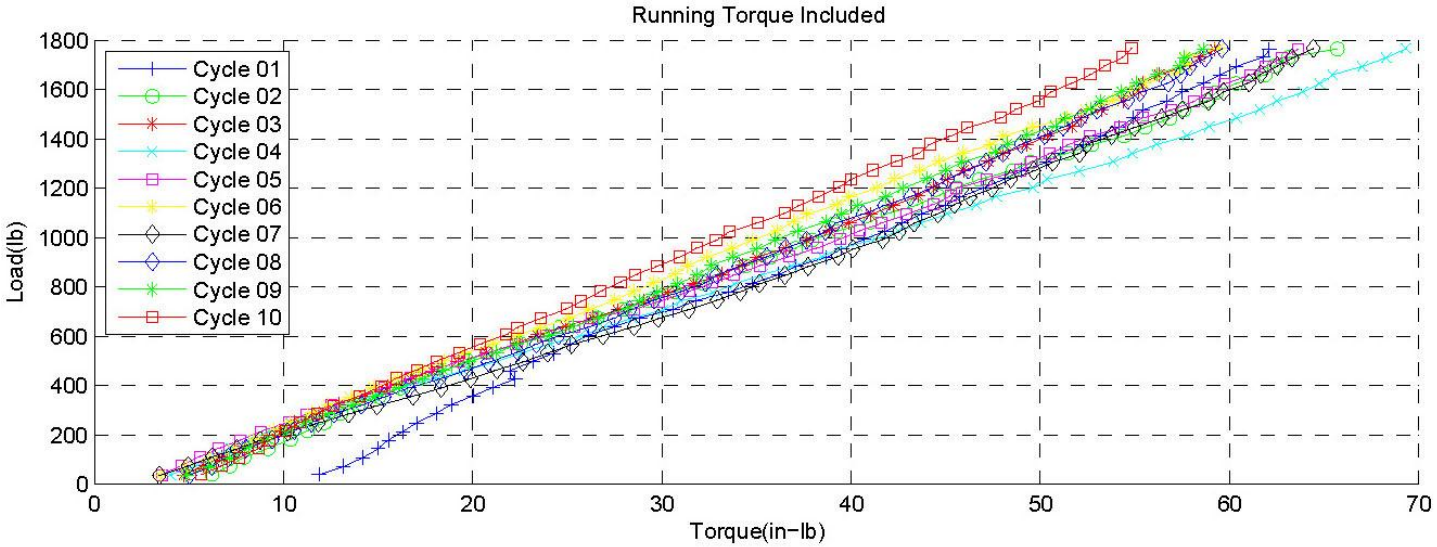
Appendix C – Full set of #10-32 Torque Tension and Running Torque Plots for ten cycles per insert, Excel® Torque Coefficient Data at 65% Pre Load, Test Plate Layouts and complete set of Run Logs.

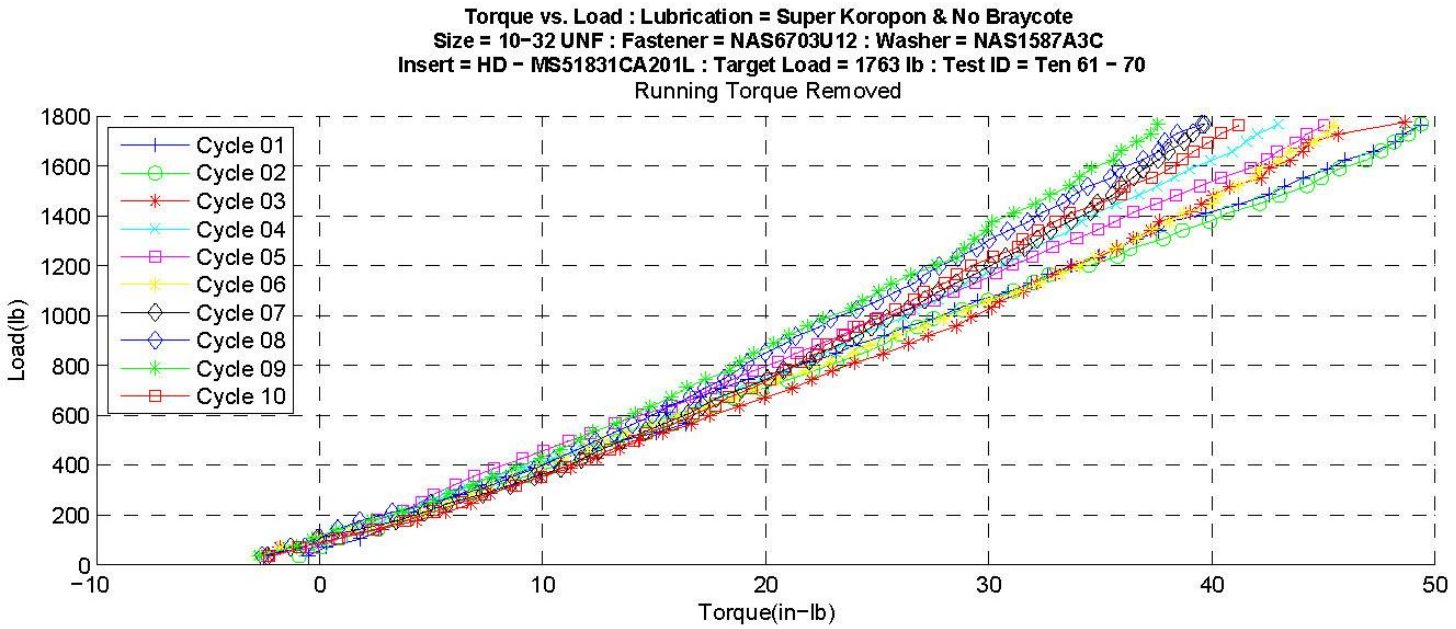
Appendix C:

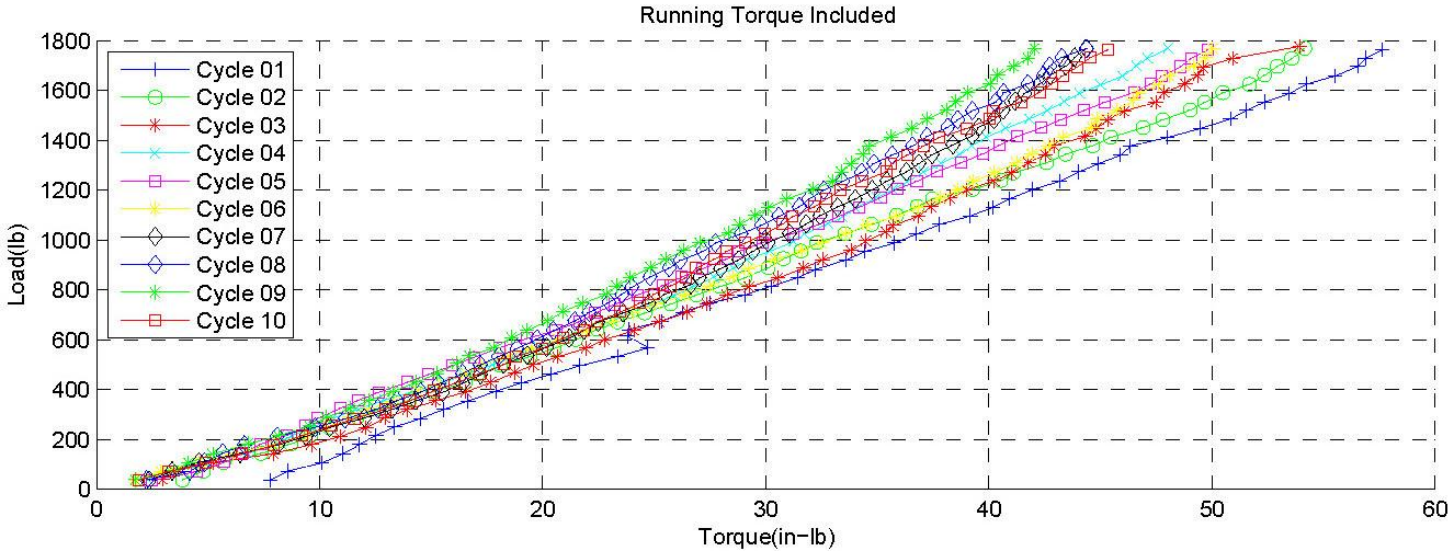
Section 1	10-32 No Braycote Torque Tension Plots
Section 2	10-32 Braycote 601 Torque Tension Plots
Section 3	10-32 Braycote 602 Torque Tension Plots
Section 4	10-32 No Braycote Running Torque Plots
Section 5	10-32 Braycote 601 Running Torque Plots
Section 6	10-32 Braycote 602 Running Torque Plots
Section 7	10-32 No Braycote Cycle Plots: Torque v. Load
Section 8	10-32 Braycote 601 Cycle Plots: Torque v. Load
Section 9	10-32 Braycote 602 Cycle Plots: Torque v. Load
Section 10	10-32 Friction Coefficients with Statistics
Section 11	10-32 Test Plate Layouts
Section 12	10-32 No Braycote Run Log
Section 13	10-32 Braycote 601 Run Logs
Section 14	10-32 Braycote 602 Run Logs

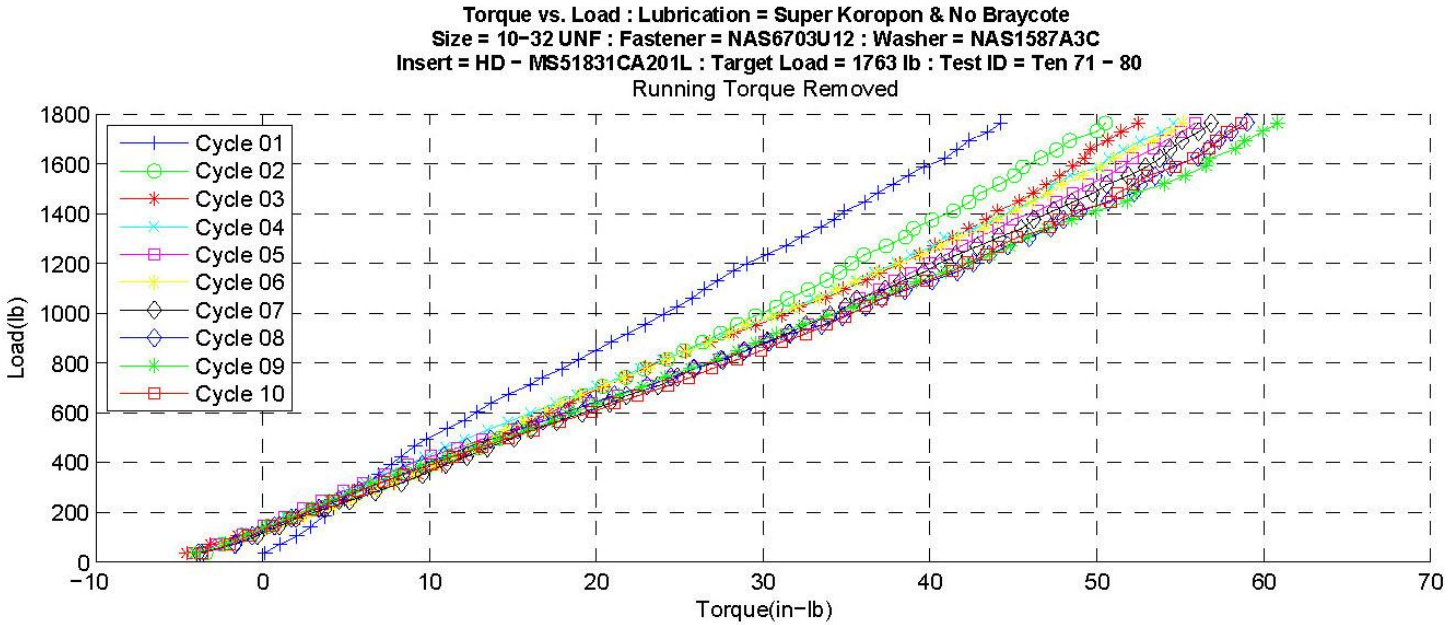

Torque vs. Load : Lubrication = Super Koropon & No Braycote
Size = 10-32 UNF : Fastener = NAS6703U12 : Washer = NAS1587A3C
Insert = ExHD - MS51832CA201L : Target Load = 1763 lb : Test ID = Ten 1 - 10
Running Torque Removed
Load(lb)
Torque(in-lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10
Running Torque Included
Load(lb)
Torque(in-lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10

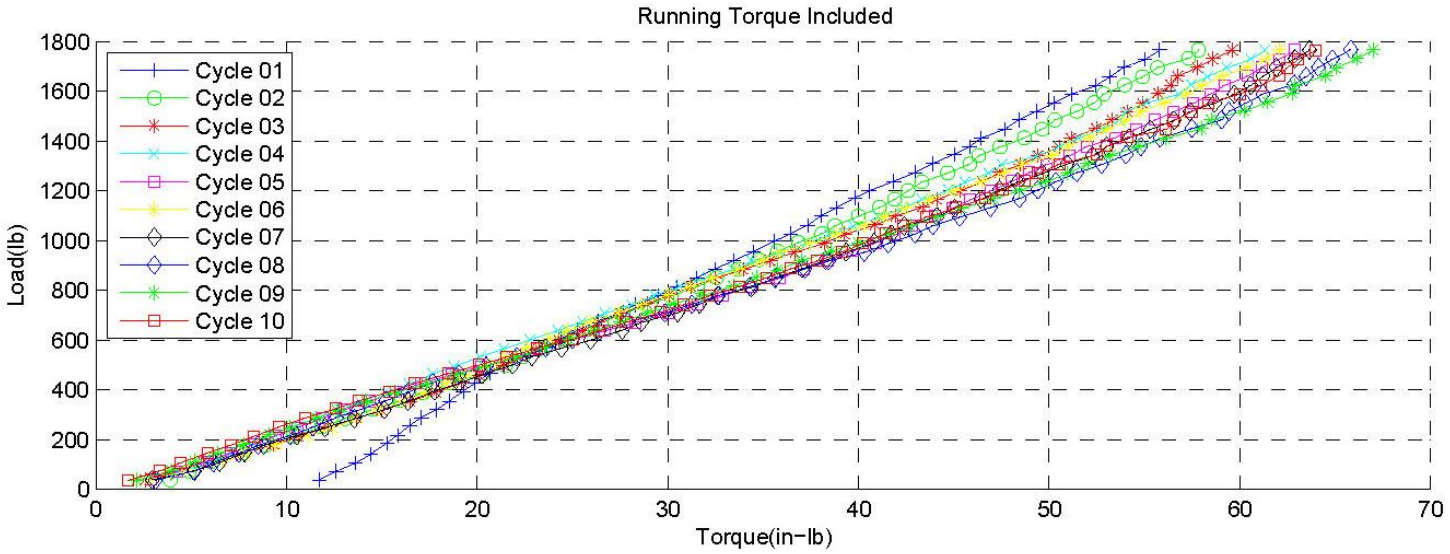

Torque vs. Load : Lubrication = Super Koropon & No Braycote
Size = 10−32 UNF : Fastener = NAS6703U12 : Washer = NAS1587A3C
Insert = HD − MS51831CA201L : Target Load = 1763 lb : Test ID = Ten 51 − 60
Running Torque Removed
Load(lb)
Torque(in−lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10


Running Torque Included
Load(lb)
Torque(in−lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10


Torque vs. Load : Lubrication = Super Koropon & No Braycote
Size = 10−32 UNF : Fastener = NAS6703U12 : Washer = NAS1587A3C
Insert = HD − MS51831CA201L : Target Load = 1763 lb : Test ID = Ten 61 − 70
Running Torque Removed
Load(lb)
Torque(in−lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10

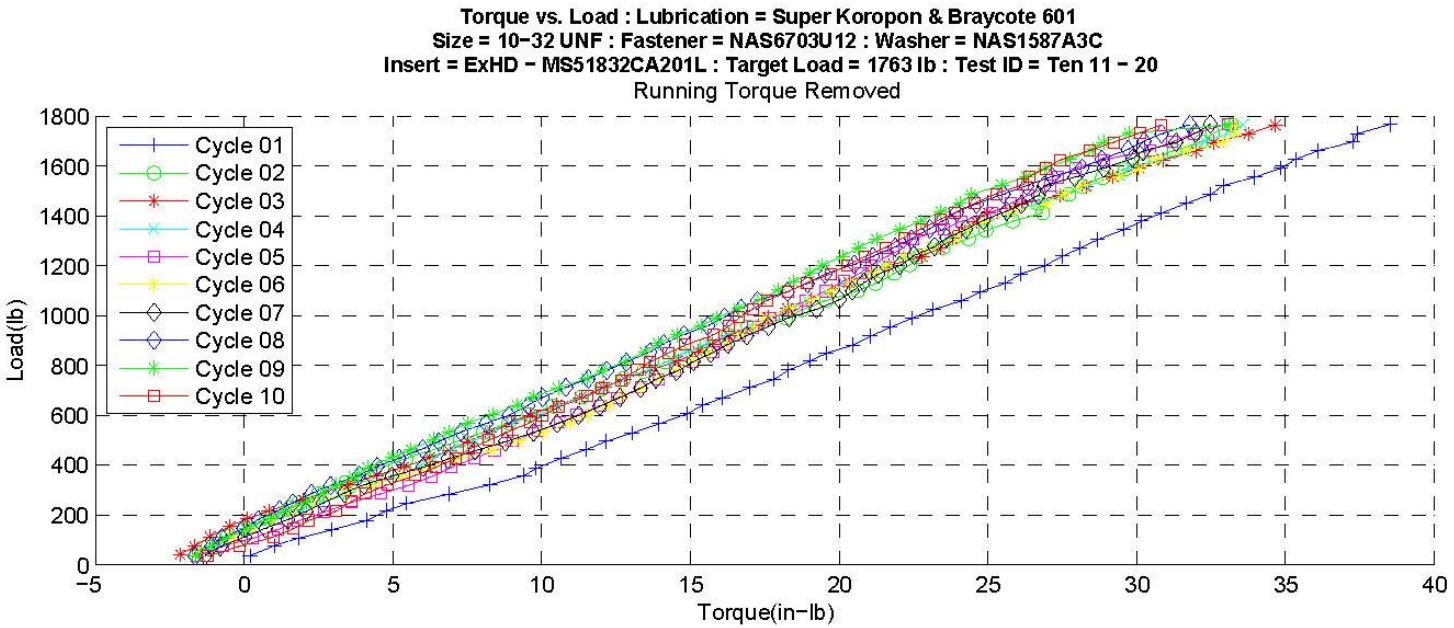

Running Torque Included
Load(lb)
Torque(in−lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10

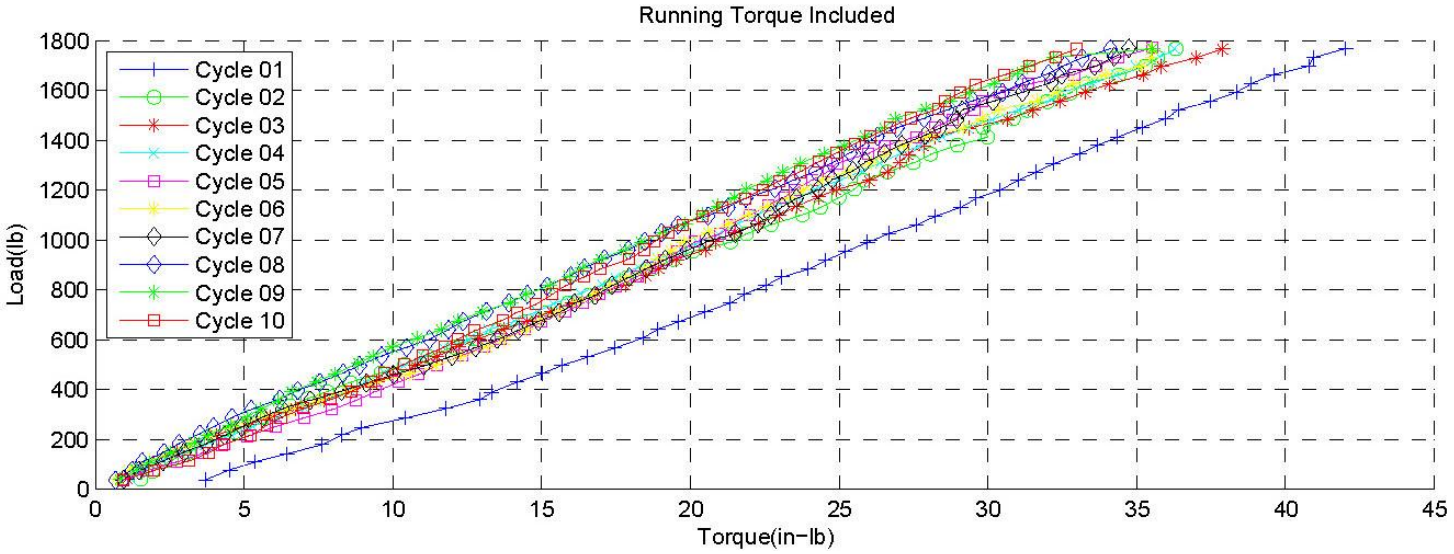

Torque vs. Load : Lubrication = Super Koropon & No Braycote
Size = 10-32 UNF : Fastener = NAS6703U12 : Washer = NAS1587A3C
Insert = HD - MS51831CA201L : Target Load = 1763 lb : Test ID = Ten 71 - 80
Running Torque Removed
Load(lb)
Torque(in-lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10

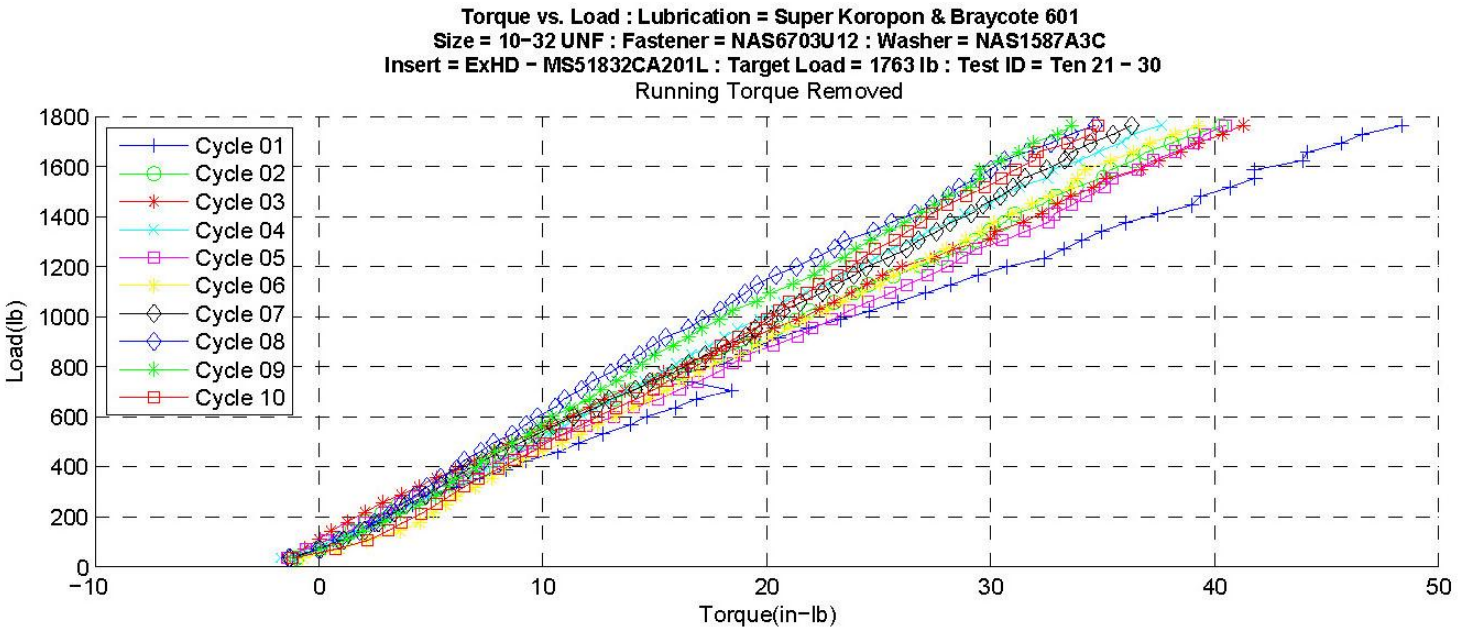

Running Torque Included
Load(lb)
Torque(in-lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10

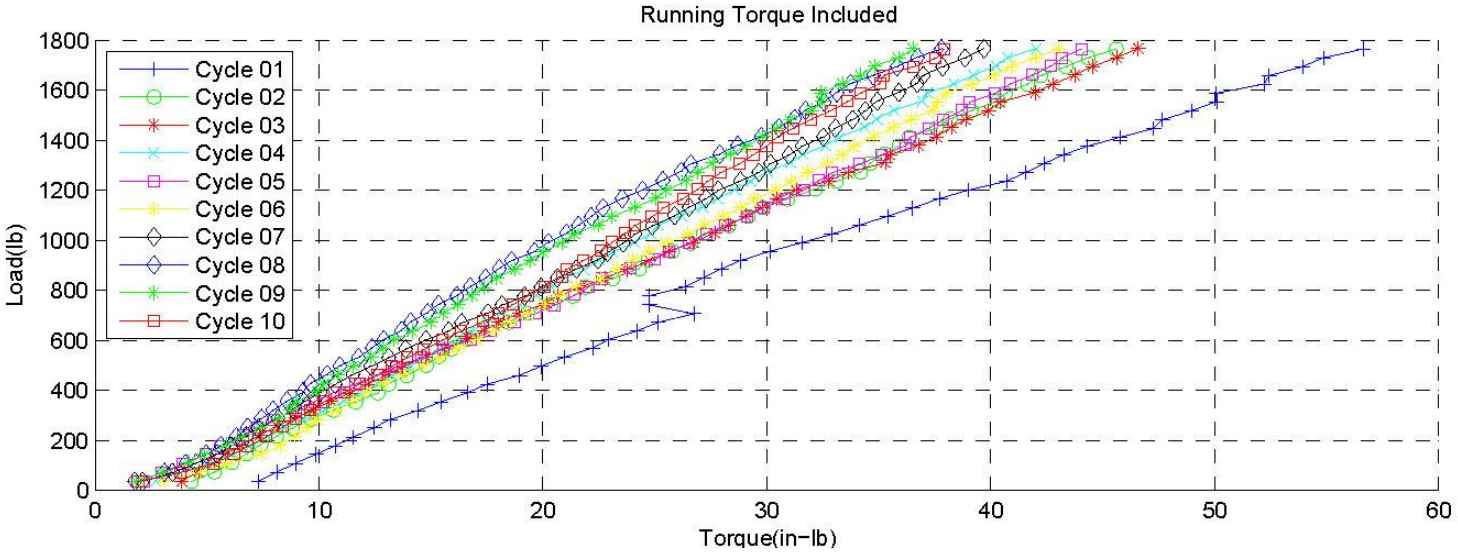
Appendix C:

Section 1	10-32 No Braycote Torque Tension Plots
Section 2	10-32 Braycote 601 Torque Tension Plots
Section 3	10-32 Braycote 602 Torque Tension Plots
Section 4	10-32 No Braycote Running Torque Plots
Section 5	10-32 Braycote 601 Running Torque Plots
Section 6	10-32 Braycote 602 Running Torque Plots
Section 7	10-32 No Braycote Cycle Plots: Torque v. Load
Section 8	10-32 Braycote 601 Cycle Plots: Torque v. Load
Section 9	10-32 Braycote 602 Cycle Plots: Torque v. Load
Section 10	10-32 Friction Coefficients with Statistics
Section 11	10-32 Test Plate Layouts
Section 12	10-32 No Braycote Run Log
Section 13	10-32 Braycote 601 Run Logs
Section 14	10-32 Braycote 602 Run Logs


Torque vs. Load : Lubrication = Super Koropon & Braycote 601
Size = 10-32 UNF : Fastener = NAS6703U12 : Washer = NAS1587A3C
Insert = ExHD - MS51832CA201L : Target Load = 1763 lb : Test ID = Ten 11 - 20
Running Torque Removed
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10
Load(lb)
Torque(in-lb)

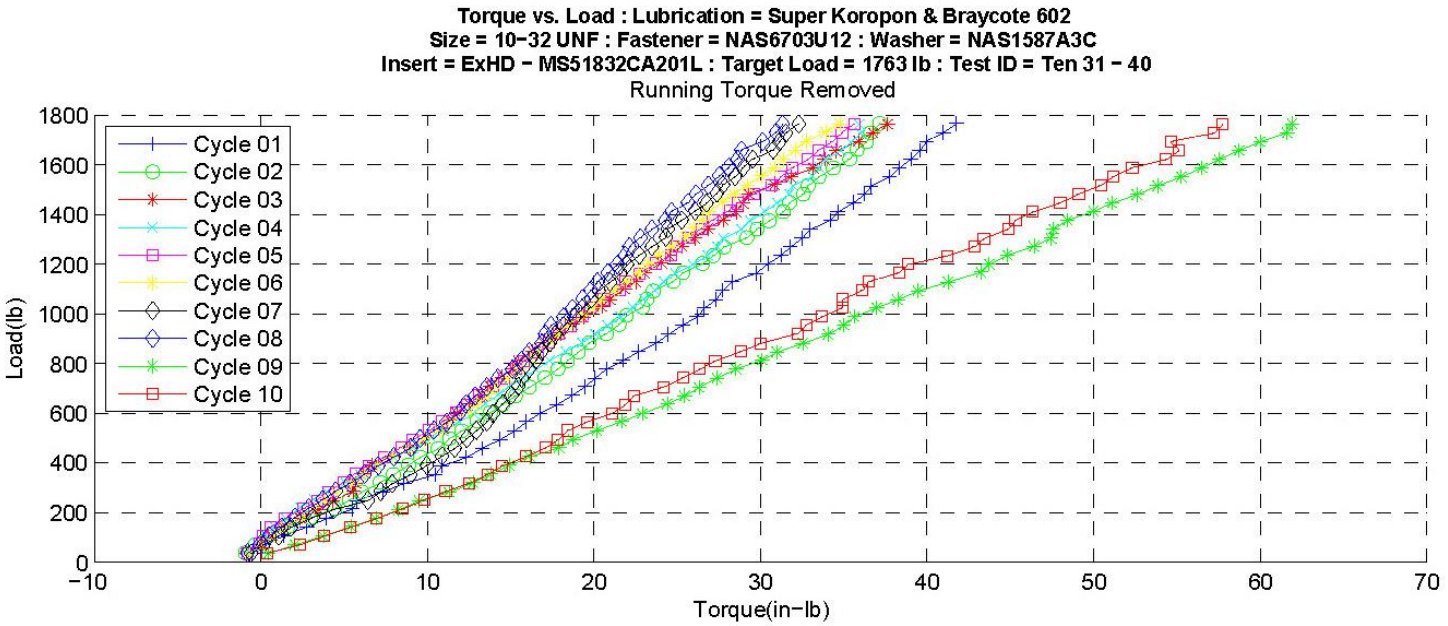

Running Torque Included
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10
Load(lb)
Torque(in-lb)

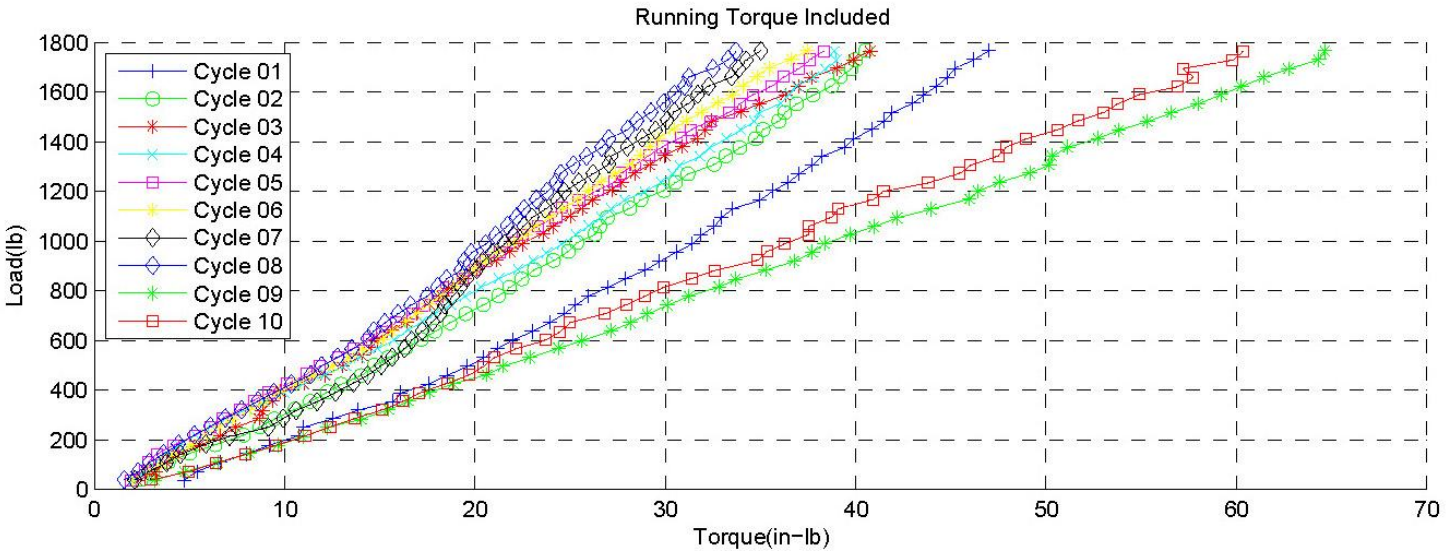

Torque vs. Load : Lubrication = Super Koropon & Braycote 601
Size = 10-32 UNF : Fastener = NAS6703U12 : Washer = NAS1587A3C
Insert = ExHD - MS51832CA201L : Target Load = 1763 lb : Test ID = Ten 21 - 30
Running Torque Removed
Load(lb)
Torque(in-lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10

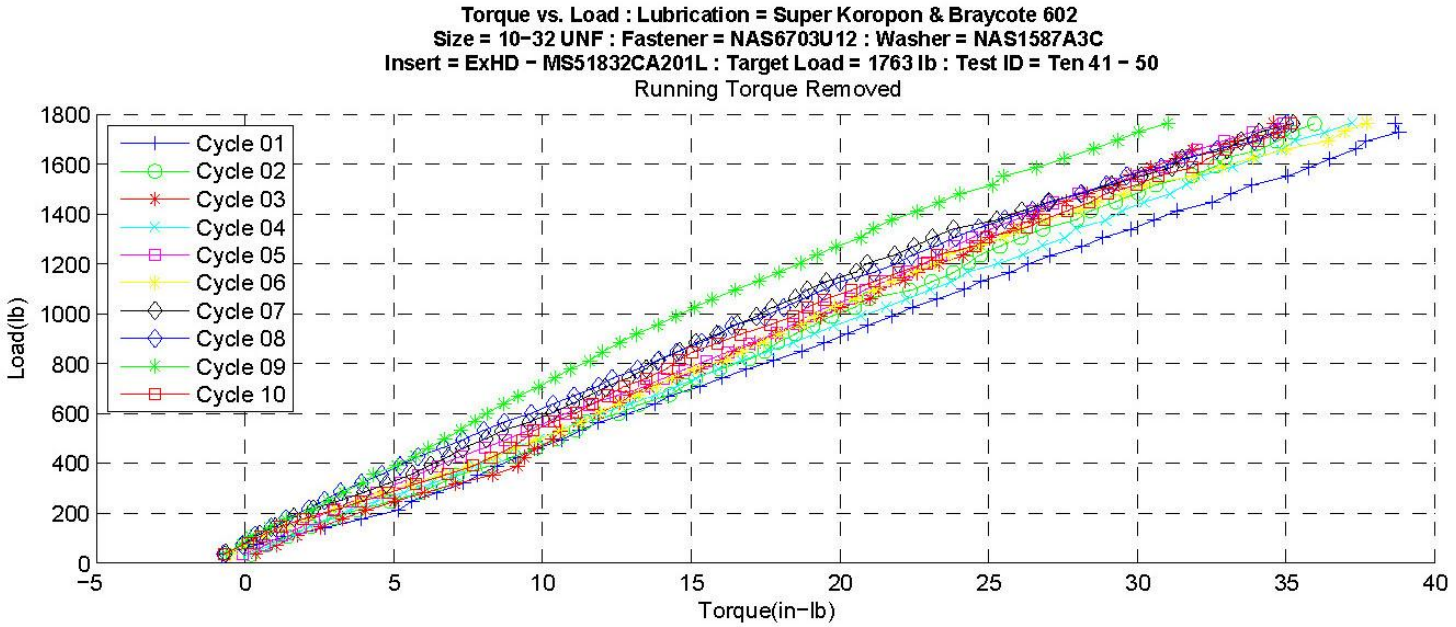

Running Torque Included
Load(lb)
Torque(in-lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10

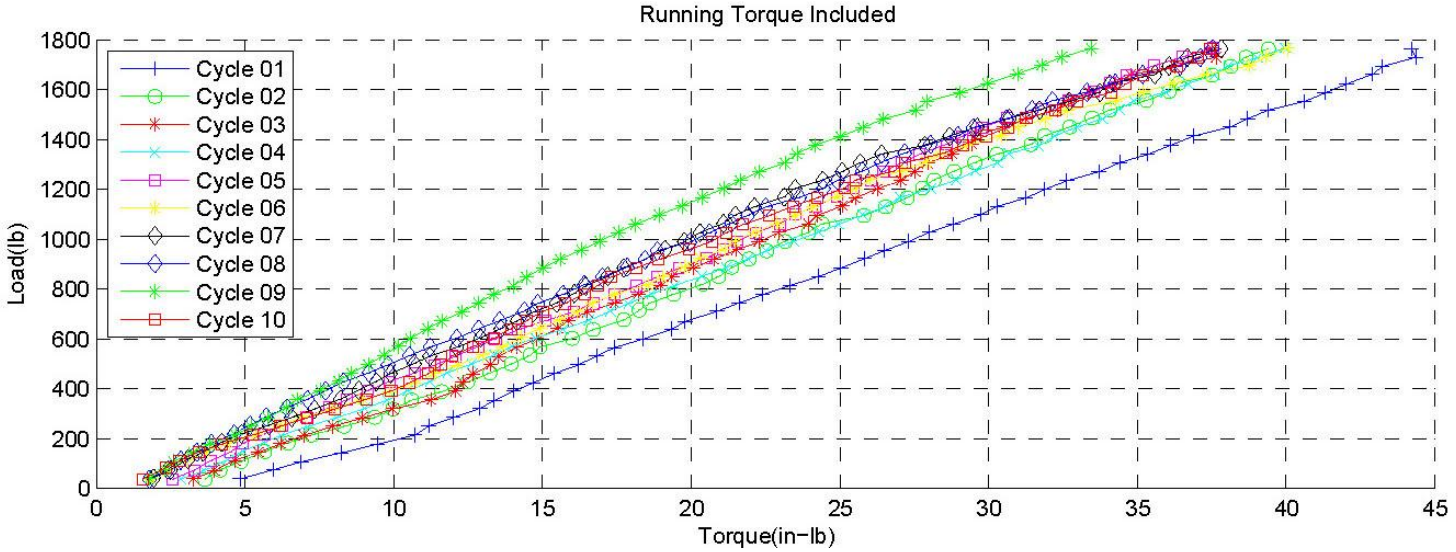
Appendix C:

Section 1	10-32 No Braycote Torque Tension Plots
Section 2	10-32 Braycote 601 Torque Tension Plots
Section 3	10-32 Braycote 602 Torque Tension Plots
Section 4	10-32 No Braycote Running Torque Plots
Section 5	10-32 Braycote 601 Running Torque Plots
Section 6	10-32 Braycote 602 Running Torque Plots
Section 7	10-32 No Braycote Cycle Plots: Torque v. Load
Section 8	10-32 Braycote 601 Cycle Plots: Torque v. Load
Section 9	10-32 Braycote 602 Cycle Plots: Torque v. Load
Section 10	10-32 Friction Coefficients with Statistics
Section 11	10-32 Test Plate Layouts
Section 12	10-32 No Braycote Run Log
Section 13	10-32 Braycote 601 Run Logs
Section 14	10-32 Braycote 602 Run Logs


Torque vs. Load : Lubrication = Super Koropon & Braycote 602
Size = 10-32 UNF : Fastener = NAS6703U12 : Washer = NAS1587A3C
Insert = ExHD - MS51832CA201L : Target Load = 1763 lb : Test ID = Ten 31 - 40
Running Torque Removed
Load(lb)
Torque(in-lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10

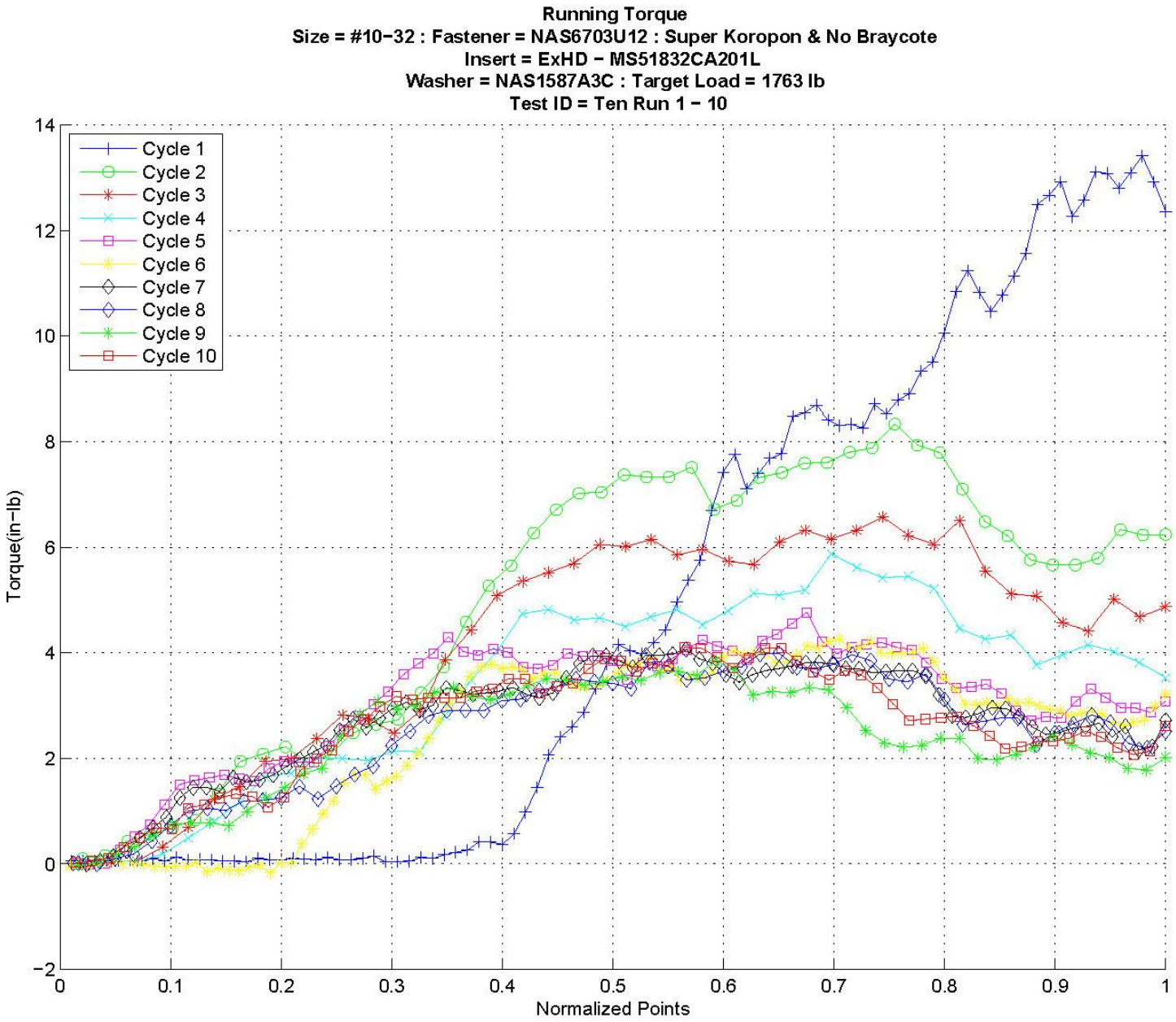

Running Torque Included
Load(lb)
Torque(in-lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10

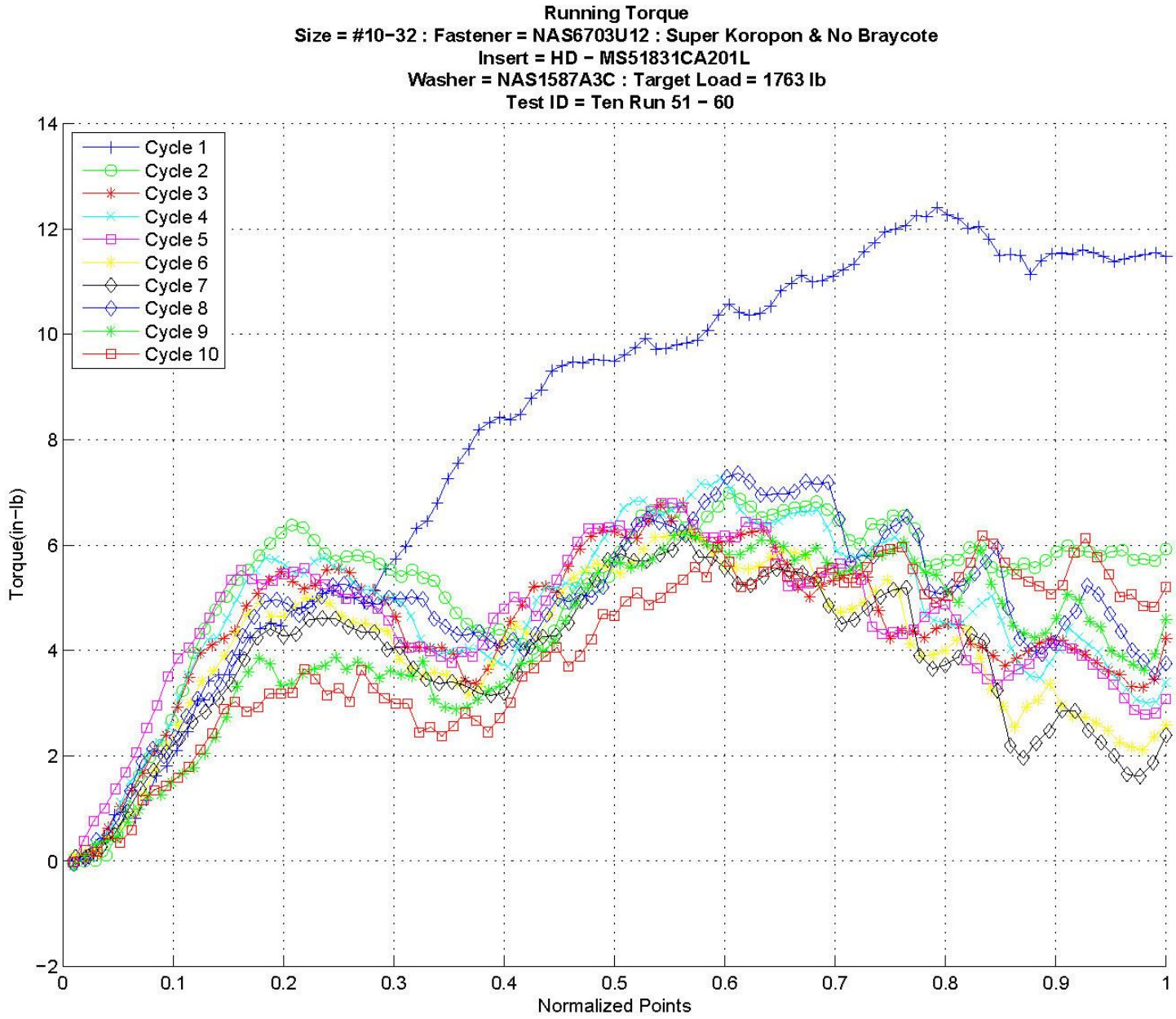

Torque vs. Load : Lubrication = Super Koropon & Braycote 602
Size = 10-32 UNF : Fastener = NAS6703U12 : Washer = NAS1587A3C
Insert = ExHD - MS51832CA201L : Target Load = 1763 lb : Test ID = Ten 41 - 50
Running Torque Removed
Load(lb)
Torque(in-lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10

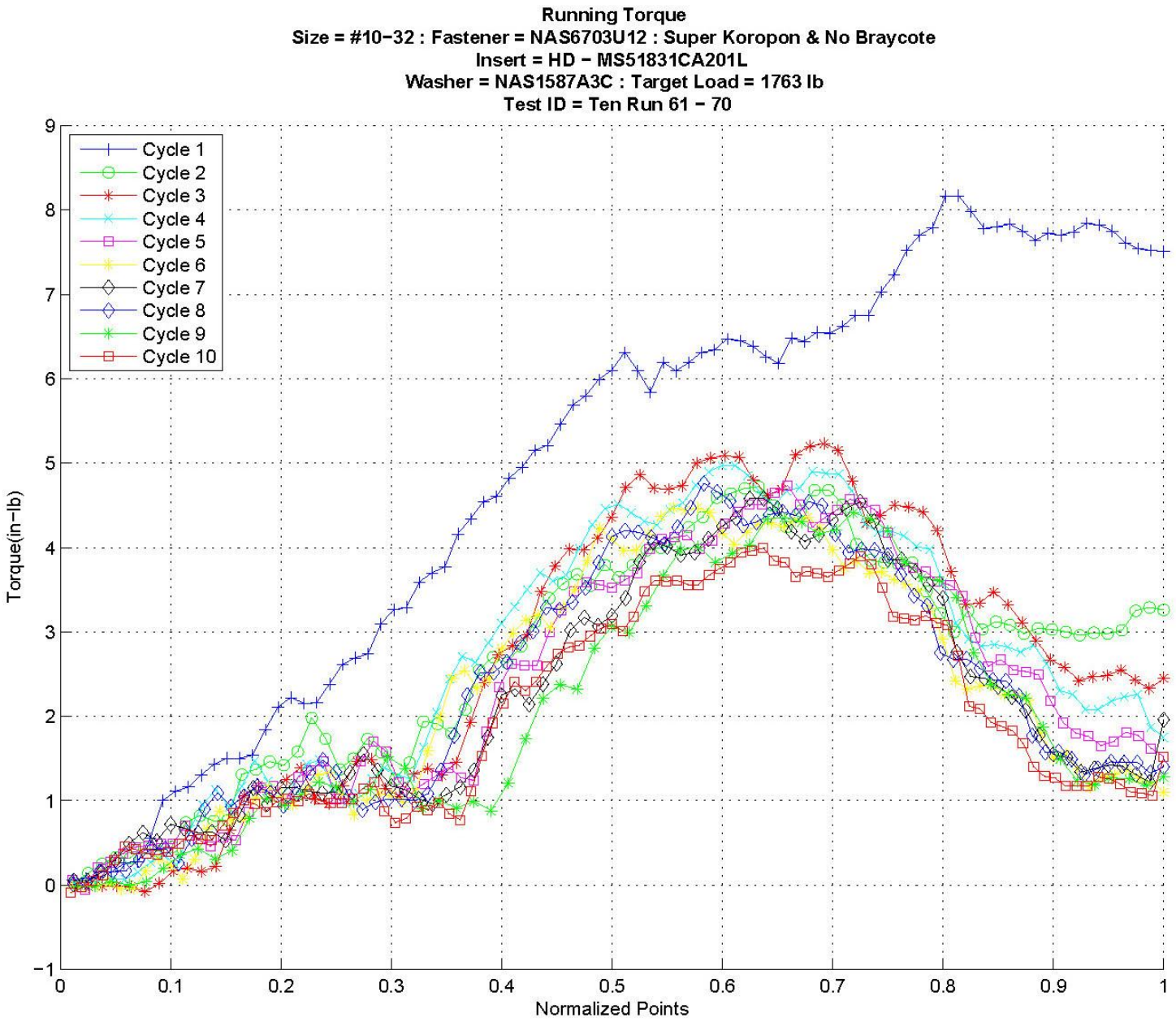

Running Torque Included
Load(lb)
Torque(in-lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10

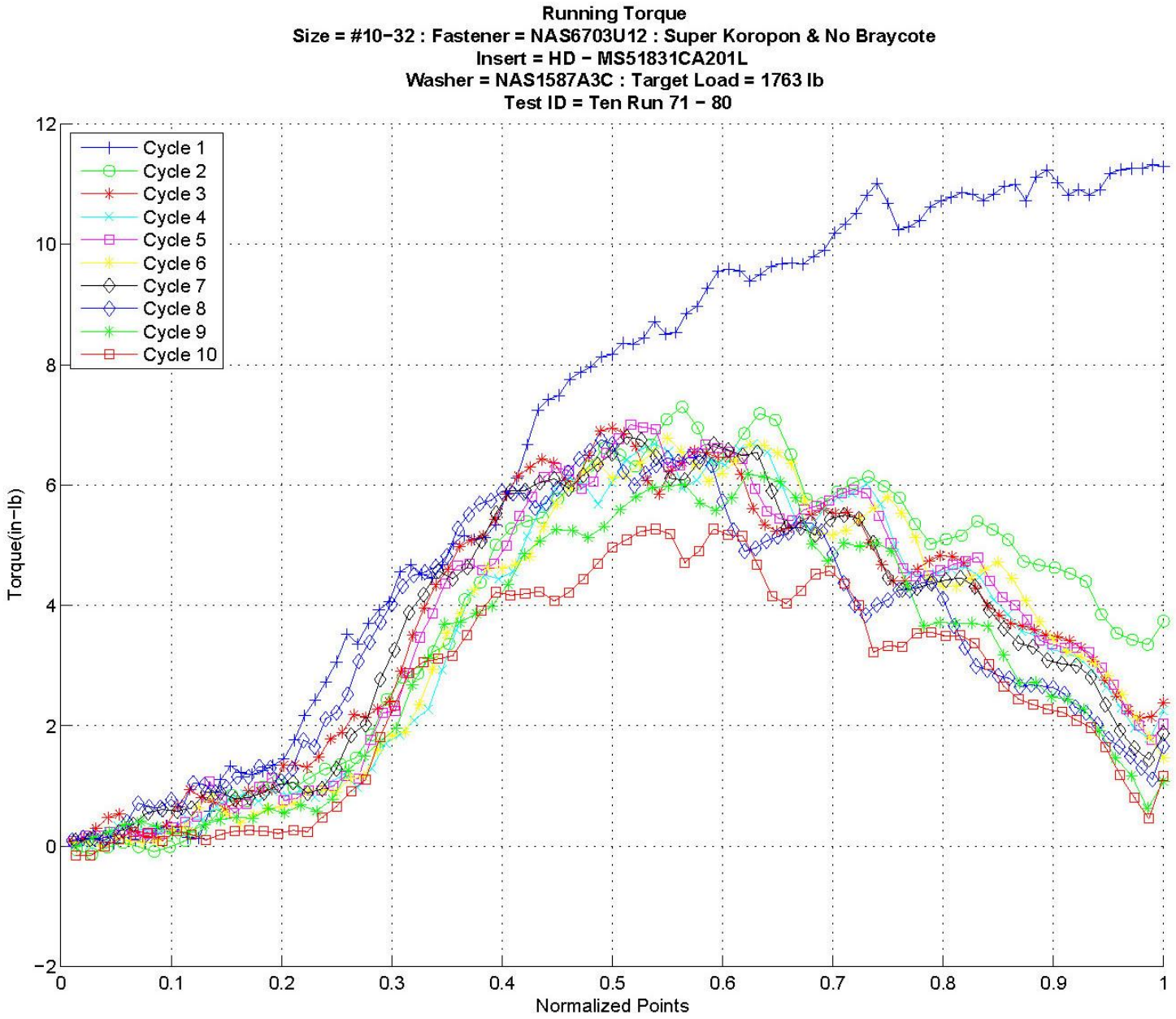
Appendix C:

Section 1	10-32 No Braycote Torque Tension Plots
Section 2	10-32 Braycote 601 Torque Tension Plots
Section 3	10-32 Braycote 602 Torque Tension Plots
Section 4	10-32 No Braycote Running Torque Plots
Section 5	10-32 Braycote 601 Running Torque Plots
Section 6	10-32 Braycote 602 Running Torque Plots
Section 7	10-32 No Braycote Cycle Plots: Torque v. Load
Section 8	10-32 Braycote 601 Cycle Plots: Torque v. Load
Section 9	10-32 Braycote 602 Cycle Plots: Torque v. Load
Section 10	10-32 Friction Coefficients with Statistics
Section 11	10-32 Test Plate Layouts
Section 12	10-32 No Braycote Run Log
Section 13	10-32 Braycote 601 Run Logs
Section 14	10-32 Braycote 602 Run Logs


Running Torque
Size = #10-32 : Fastener = NAS6703U12 : Super Koropon & No Braycote
Insert = ExHD - MS51832CA201L
Washer = NAS1587A3C : Target Load = 1763 lb
Test ID = Ten Run 1 - 10
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Cycle 7
Cycle 8
Cycle 9
Cycle 10
Torque(in-lb)
Normalized Points
14
12
10
8
6
4
2
0
-2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

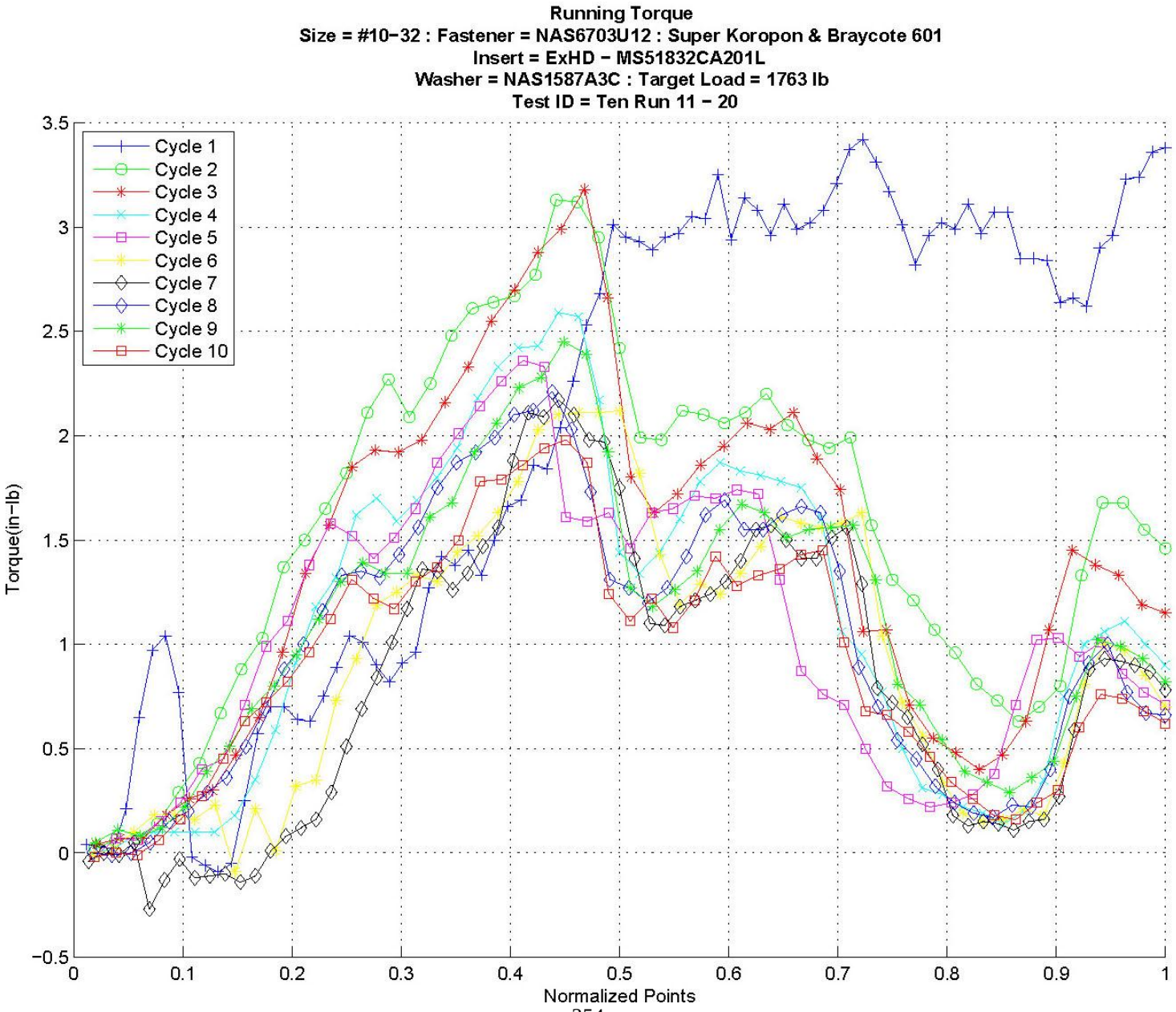

Running Torque
Size = #10−32 : Fastener = NAS6703U12 : Super Koropon & No Braycote
Insert = HD − MS51831CA201L
Washer = NAS1587A3C : Target Load = 1763 lb
Test ID = Ten Run 51 − 60
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Cycle 7
Cycle 8
Cycle 9
Cycle 10
Torque(in−lb)
Normalized Points
14
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

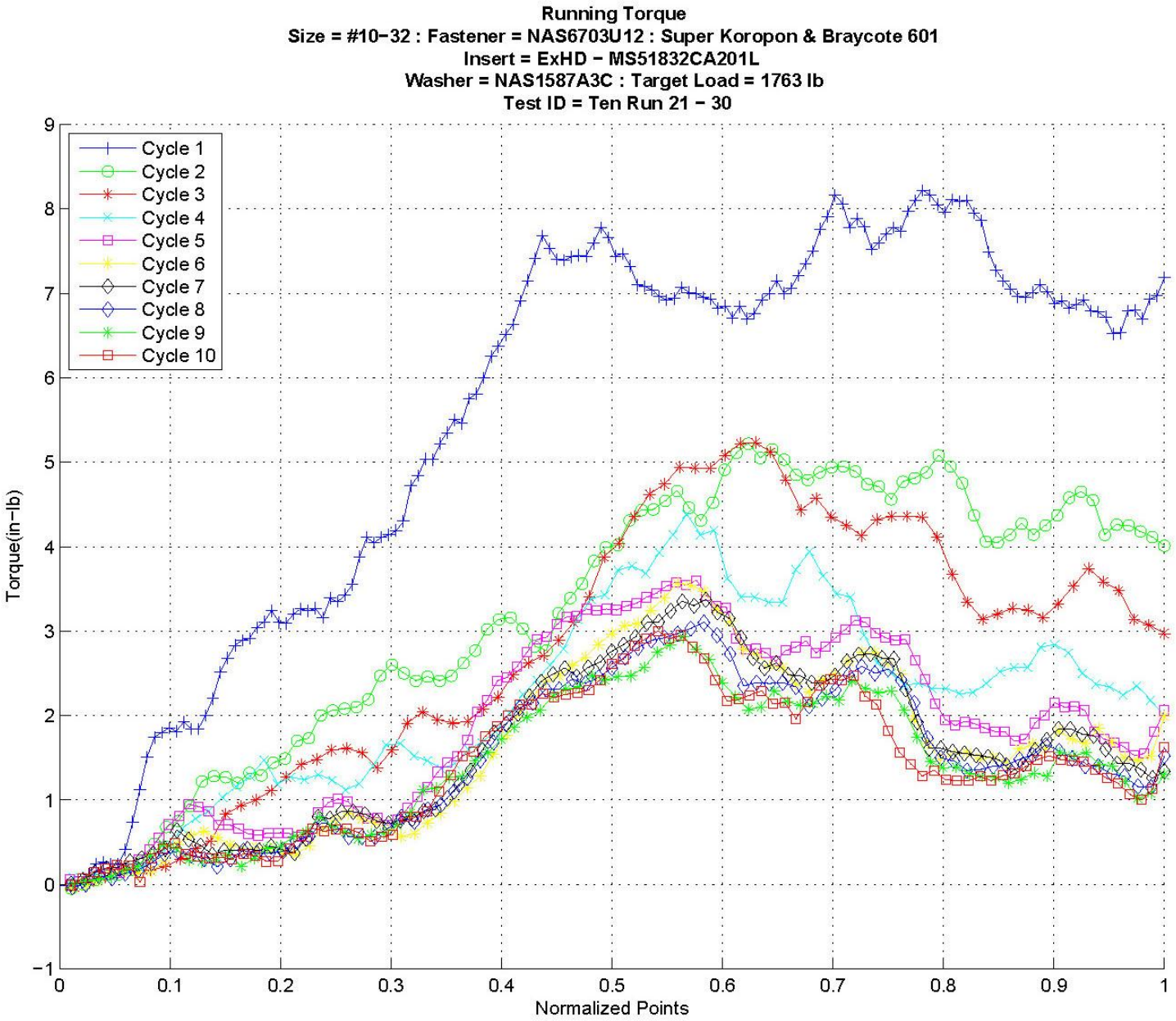

Running Torque
Size = #10−32 : Fastener = NAS6703U12 : Super Koropon & No Braycote
Insert = HD − MS51831CA201L
Washer = NAS1587A3C : Target Load = 1763 lb
Test ID = Ten Run 61 − 70
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Cycle 7
Cycle 8
Cycle 9
Cycle 10
Torque(in−lb)
Normalized Points
9
8
7
6
5
4
3
2
1
0
−1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


Running Torque
Size = #10−32 : Fastener = NAS6703U12 : Super Koropon & No Braycote
Insert = HD − MS51831CA201L
Washer = NAS1587A3C : Target Load = 1763 lb
Test ID = Ten Run 71 − 80
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Cycle 7
Cycle 8
Cycle 9
Cycle 10
Torque(in−lb)
Normalized Points
12
10
8
6
4
2
0
−2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

Appendix C:

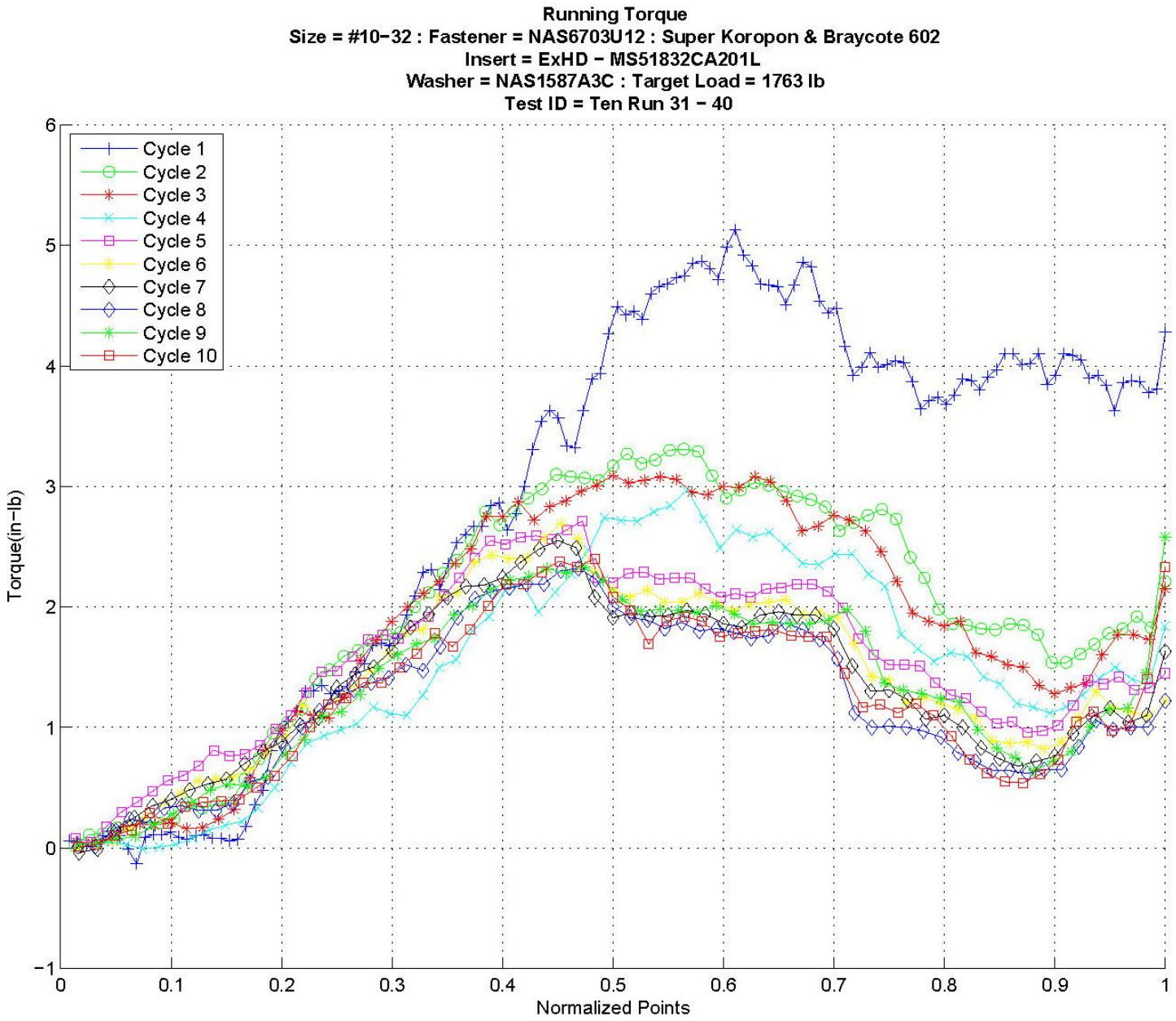
Section 1	10-32 No Braycote Torque Tension Plots
Section 2	10-32 Braycote 601 Torque Tension Plots
Section 3	10-32 Braycote 602 Torque Tension Plots
Section 4	10-32 No Braycote Running Torque Plots
Section 5	10-32 Braycote 601 Running Torque Plots
Section 6	10-32 Braycote 602 Running Torque Plots
Section 7	10-32 No Braycote Cycle Plots: Torque v. Load
Section 8	10-32 Braycote 601 Cycle Plots: Torque v. Load
Section 9	10-32 Braycote 602 Cycle Plots: Torque v. Load
Section 10	10-32 Friction Coefficients with Statistics
Section 11	10-32 Test Plate Layouts
Section 12	10-32 No Braycote Run Log
Section 13	10-32 Braycote 601 Run Logs
Section 14	10-32 Braycote 602 Run Logs

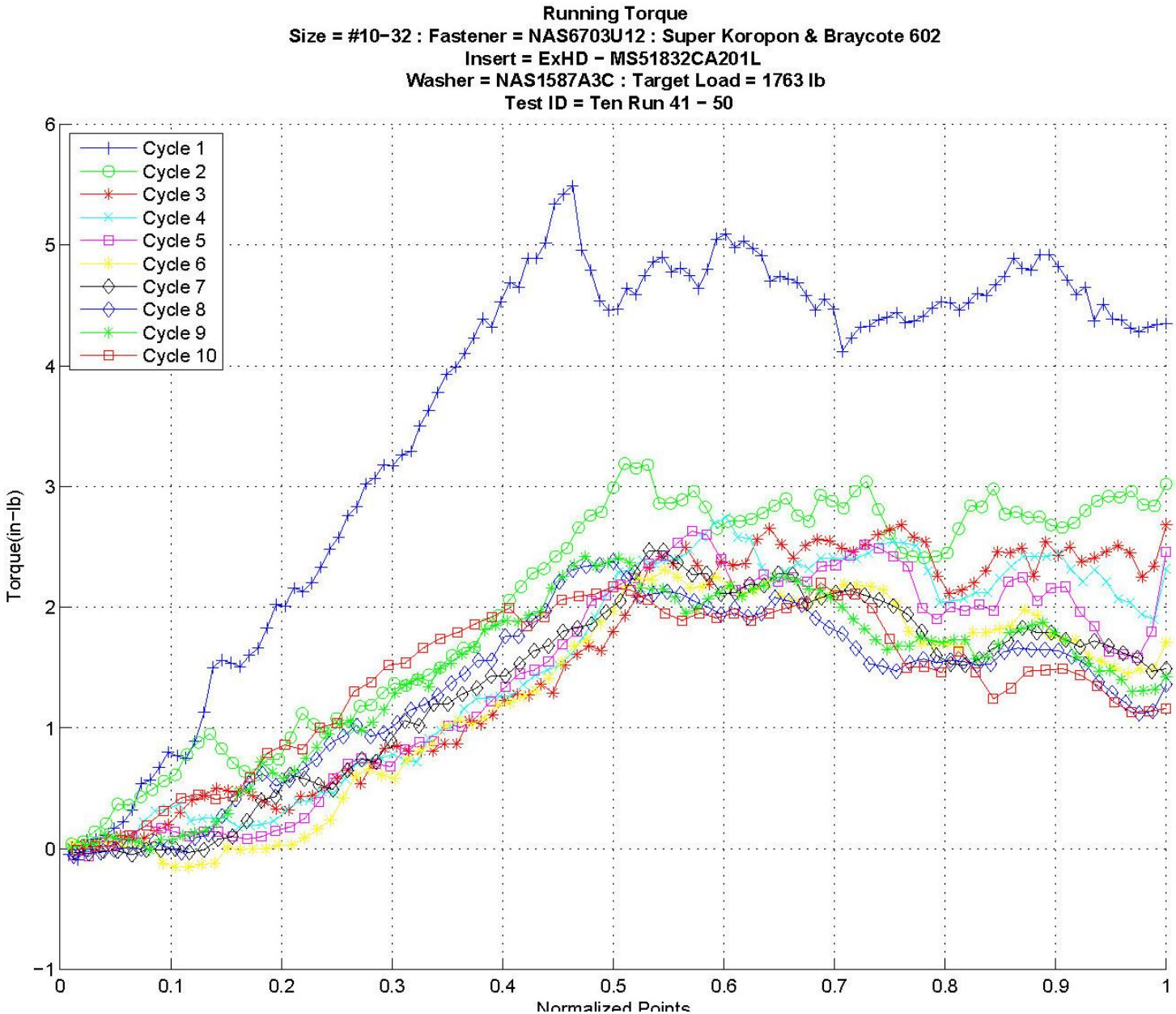

Running Torque
Size = #10−32 : Fastener = NAS6703U12 : Super Koropon & Braycote 601
Insert = ExHD − MS51832CA201L
Washer = NAS1587A3C : Target Load = 1763 lb
Test ID = Ten Run 11 − 20
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Cycle 7
Cycle 8
Cycle 9
Cycle 10
Torque(in−lb)
Normalized Points
3.5
3
2.5
2
1.5
1
0.5
0
−0.5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


Running Torque
Size = #10−32 : Fastener = NAS6703U12 : Super Koropon & Braycote 601
Insert = ExHD − MS51832CA201L
Washer = NAS1587A3C : Target Load = 1763 lb
Test ID = Ten Run 21 − 30
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Cycle 7
Cycle 8
Cycle 9
Cycle 10
Torque(in−lb)
Normalized Points
9
8
7
6
5
4
3
2
1
0
−1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

Appendix C:

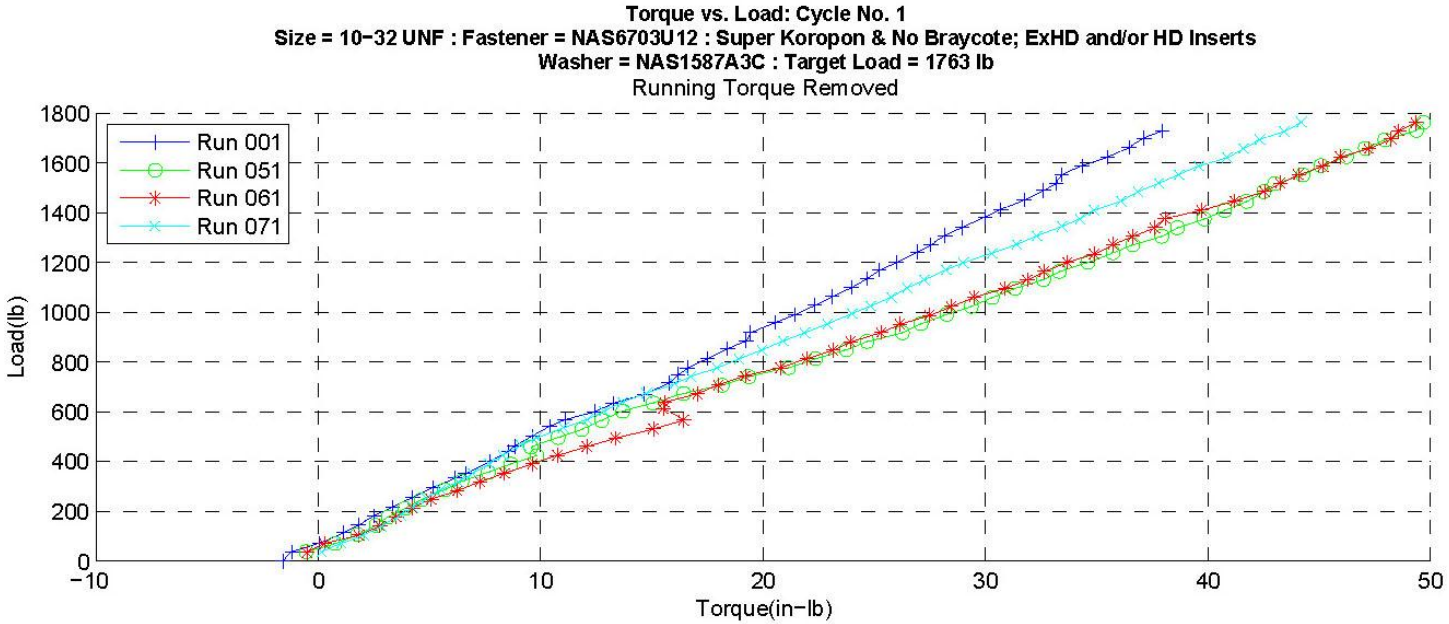
Section 1	10-32 No Braycote Torque Tension Plots
Section 2	10-32 Braycote 601 Torque Tension Plots
Section 3	10-32 Braycote 602 Torque Tension Plots
Section 4	10-32 No Braycote Running Torque Plots
Section 5	10-32 Braycote 601 Running Torque Plots
Section 6	10-32 Braycote 602 Running Torque Plots
Section 7	10-32 No Braycote Cycle Plots: Torque v. Load
Section 8	10-32 Braycote 601 Cycle Plots: Torque v. Load
Section 9	10-32 Braycote 602 Cycle Plots: Torque v. Load
Section 10	10-32 Friction Coefficients with Statistics
Section 11	10-32 Test Plate Layouts
Section 12	10-32 No Braycote Run Log
Section 13	10-32 Braycote 601 Run Logs
Section 14	10-32 Braycote 602 Run Logs

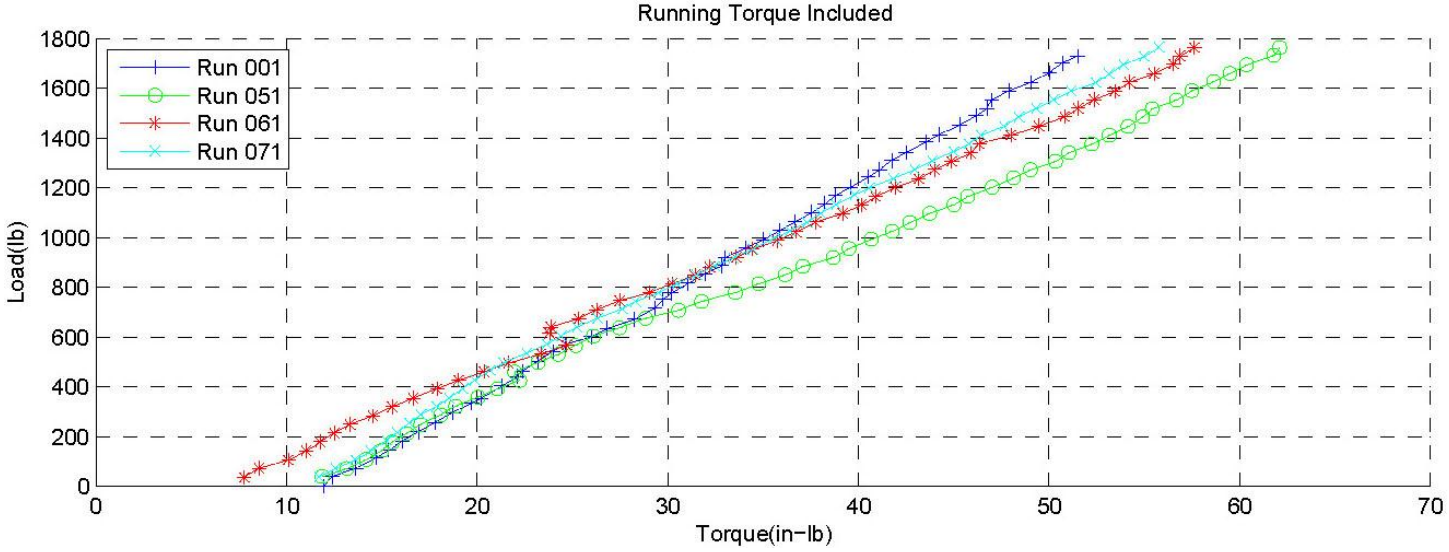

Running Torque
Size = #10−32 : Fastener = NAS6703U12 : Super Koropon & Braycote 602
Insert = ExHD − MS51832CA201L
Washer = NAS1587A3C : Target Load = 1763 lb
Test ID = Ten Run 31 − 40
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Cycle 7
Cycle 8
Cycle 9
Cycle 10
Torque(in−lb)
Normalized Points
6
5
4
3
2
1
0
−1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

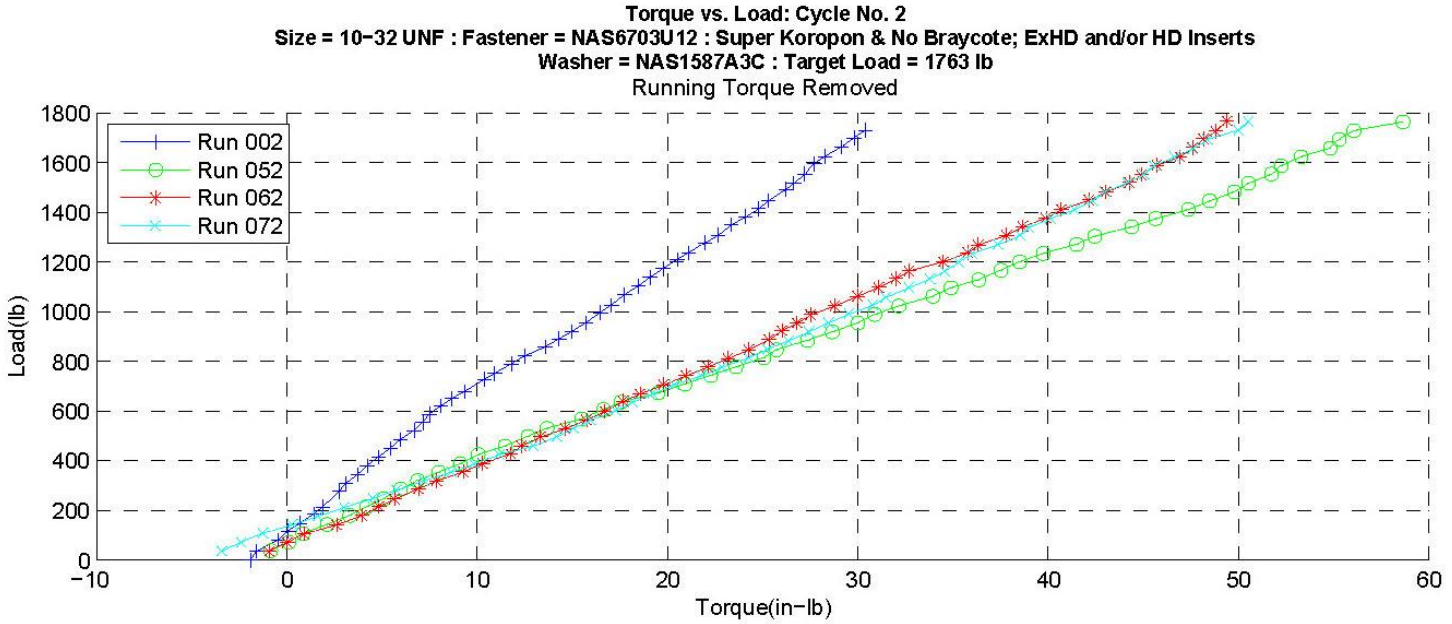

Running Torque
Size = #10−32 : Fastener = NAS6703U12 : Super Koropon & Braycote 602
Insert = ExHD − MS51832CA201L
Washer = NAS1587A3C : Target Load = 1763 lb
Test ID = Ten Run 41 − 50
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Cycle 7
Cycle 8
Cycle 9
Cycle 10
Torque(in−lb)
Normalized Points
6
5
4
3
2
1
0
−1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

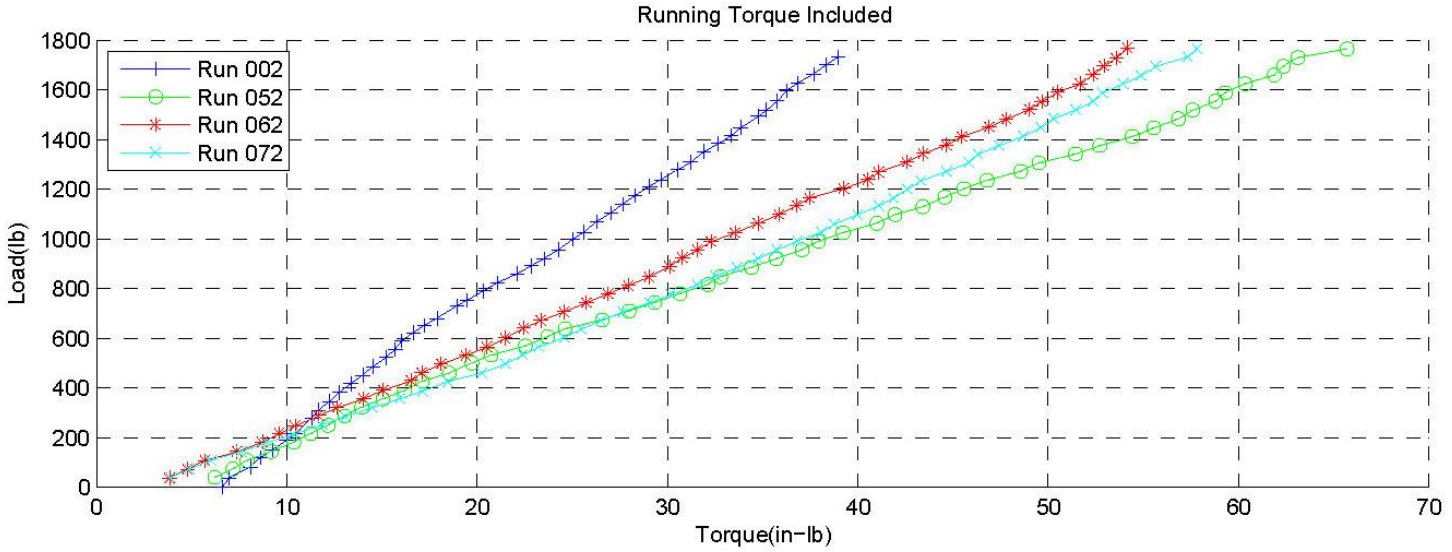
Appendix C:

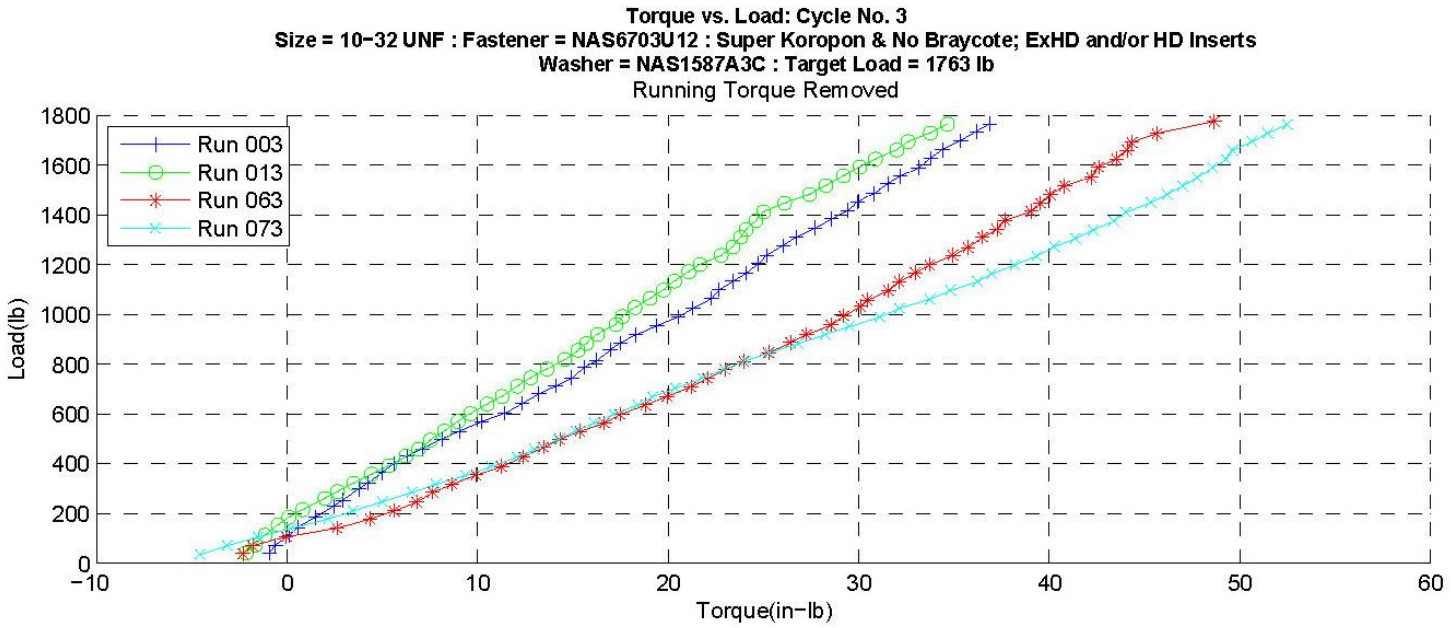
Section 1	10-32 No Braycote Torque Tension Plots
Section 2	10-32 Braycote 601 Torque Tension Plots
Section 3	10-32 Braycote 602 Torque Tension Plots
Section 4	10-32 No Braycote Running Torque Plots
Section 5	10-32 Braycote 601 Running Torque Plots
Section 6	10-32 Braycote 602 Running Torque Plots
Section 7	10-32 No Braycote Cycle Plots: Torque v. Load
Section 8	10-32 Braycote 601 Cycle Plots: Torque v. Load
Section 9	10-32 Braycote 602 Cycle Plots: Torque v. Load
Section 10	10-32 Friction Coefficients with Statistics
Section 11	10-32 Test Plate Layouts
Section 12	10-32 No Braycote Run Log
Section 13	10-32 Braycote 601 Run Logs
Section 14	10-32 Braycote 602 Run Logs

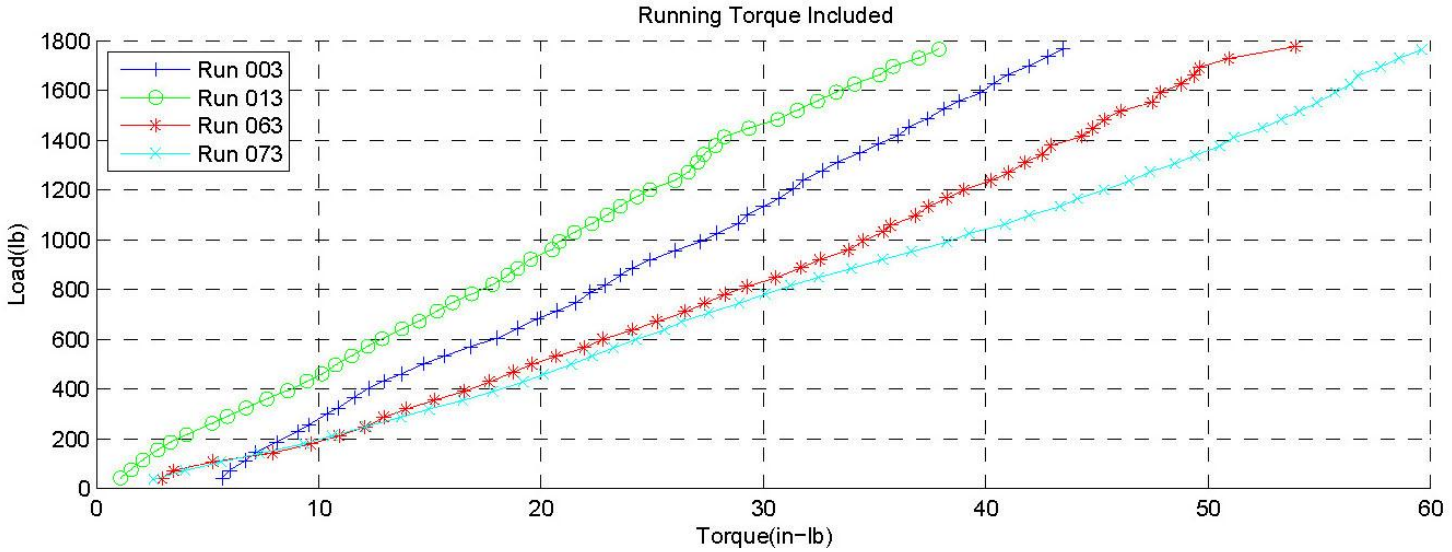

Torque vs. Load: Cycle No. 1
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & No Braycote; ExHD and/or HD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 001
Run 051
Run 061
Run 071
Load(lb)
Torque(in-lb)
0
200
400
600
800
1000
1200
1400
1600
1800
-10
0
10
20
30
40
50

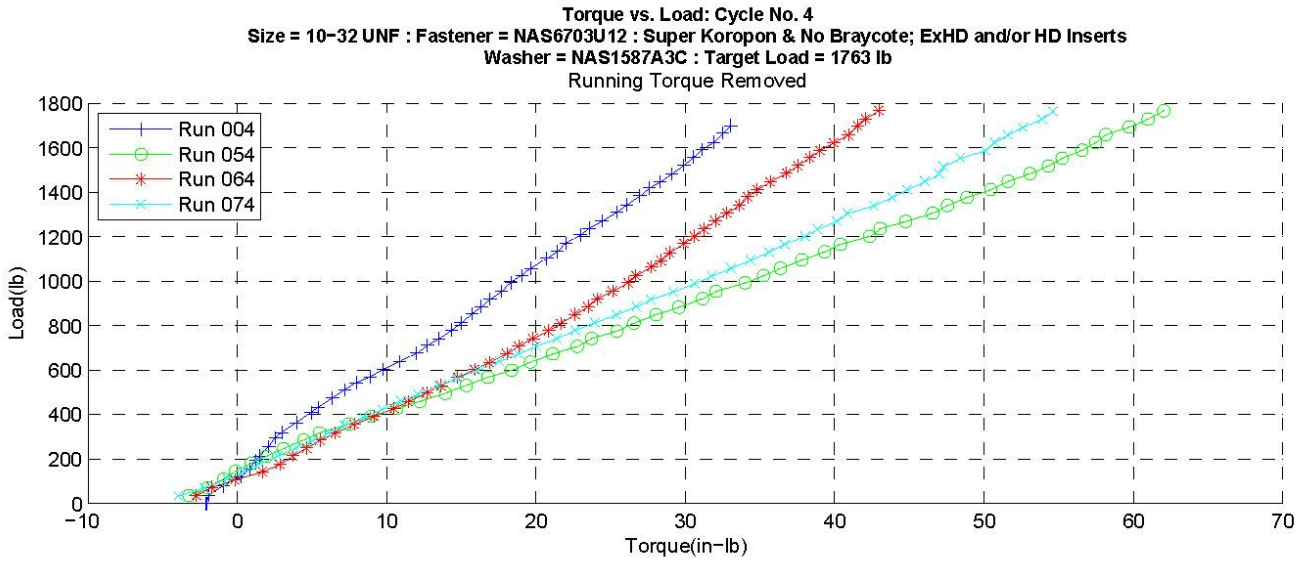

Running Torque Included
Run 001
Run 051
Run 061
Run 071
Load(lb)
Torque(in-lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
10
20
30
40
50
60
70

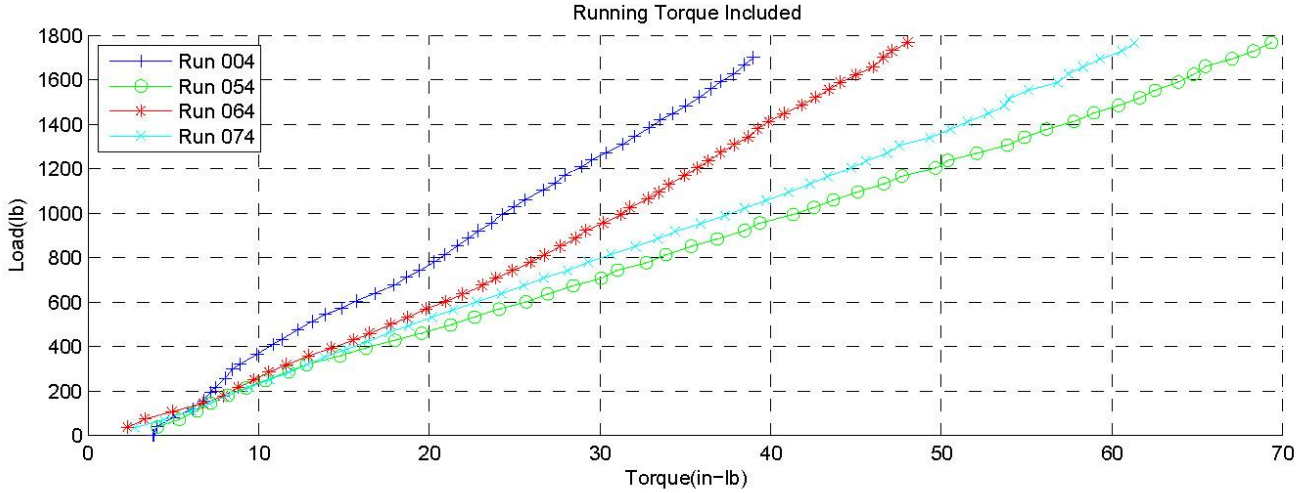

Torque vs. Load: Cycle No. 2
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & No Braycote; ExHD and/or HD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 002
Run 052
Run 062
Run 072
Load(lb)
Torque(in-lb)
0
200
400
600
800
1000
1200
1400
1600
1800
-10
0
10
20
30
40
50
60

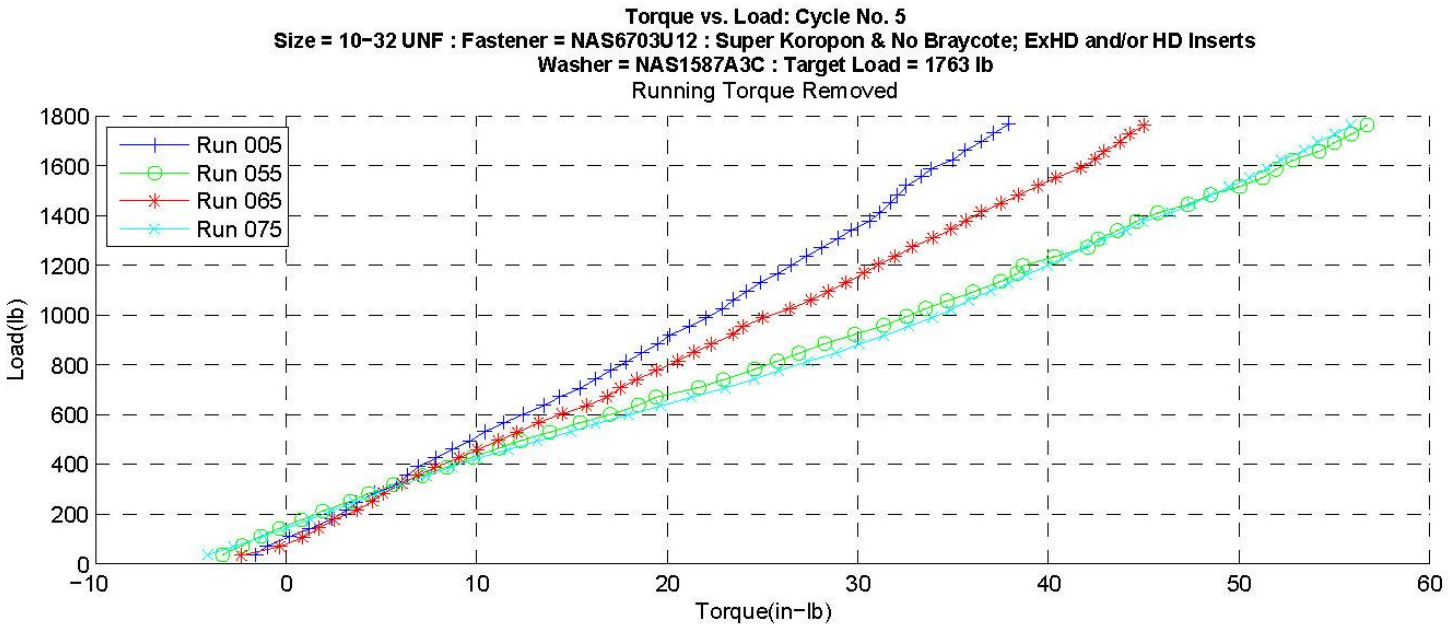

Running Torque Included
Run 002
Run 052
Run 062
Run 072
Load(lb)
Torque(in-lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
10
20
30
40
50
60
70

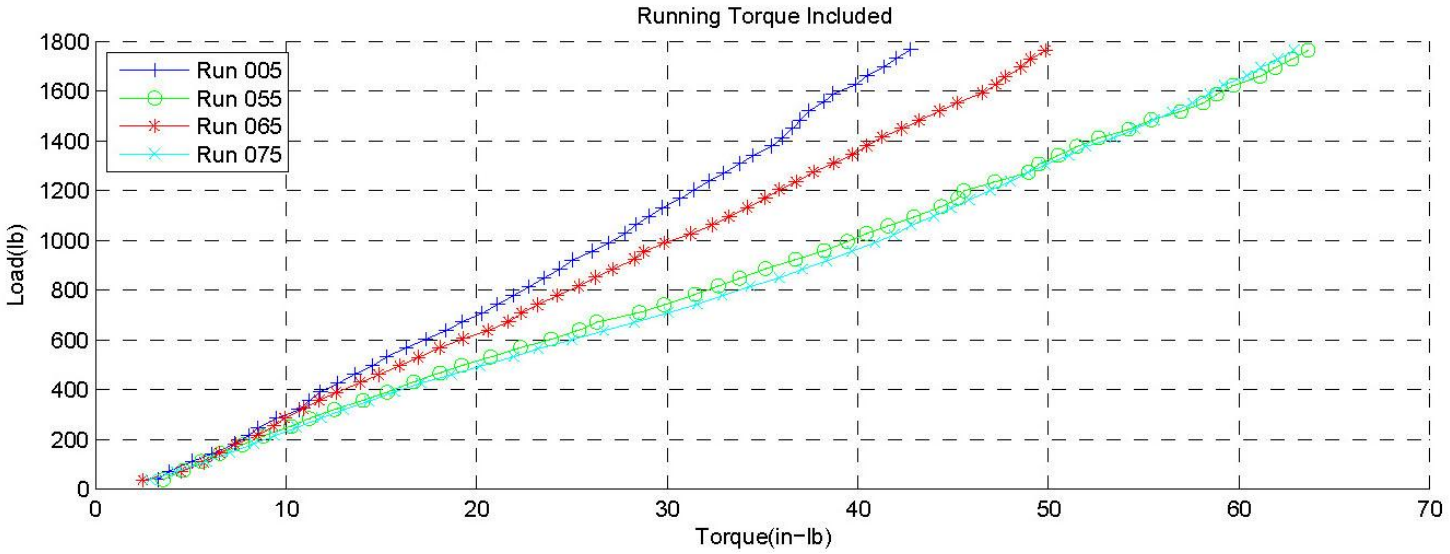

Torque vs. Load: Cycle No. 3
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & No Braycote; ExHD and/or HD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 003
Run 013
Run 063
Run 073
Load(lb)
Torque(in-lb)
0
200
400
600
800
1000
1200
1400
1600
1800
-10
0
10
20
30
40
50
60

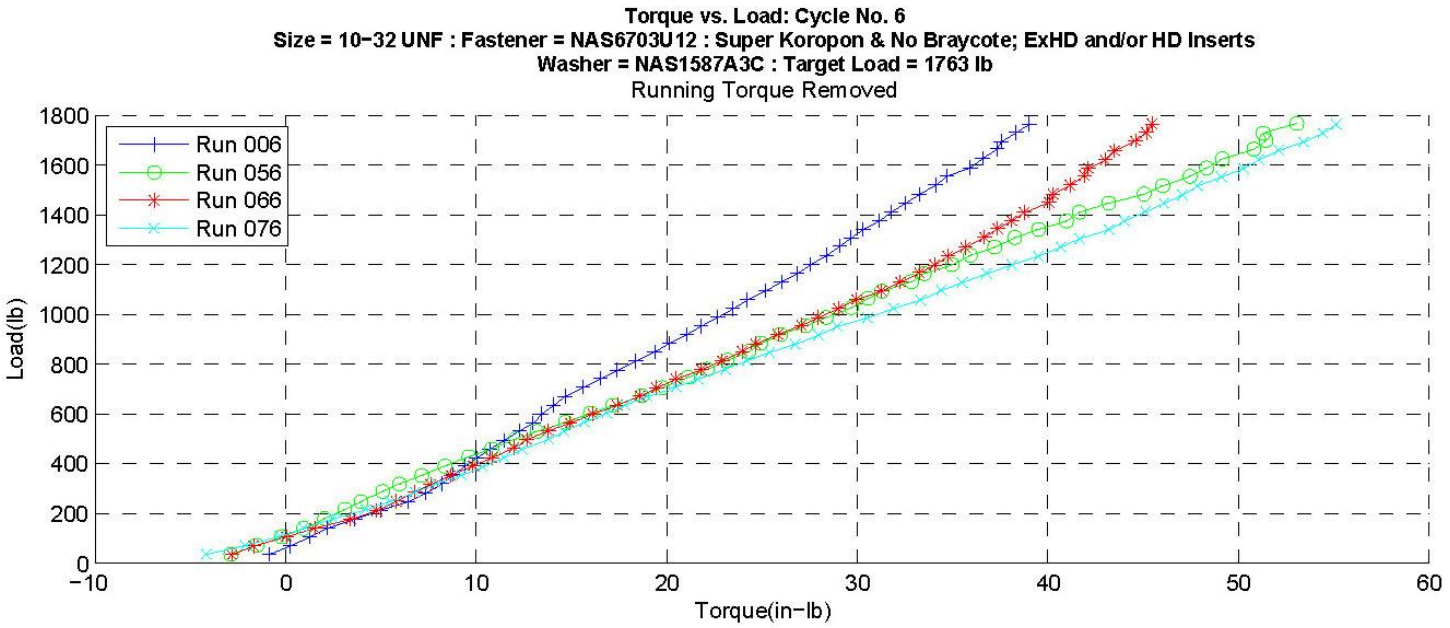

Running Torque Included
Run 003
Run 013
Run 063
Run 073
Load(lb)
Torque(in-lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
10
20
30
40
50
60

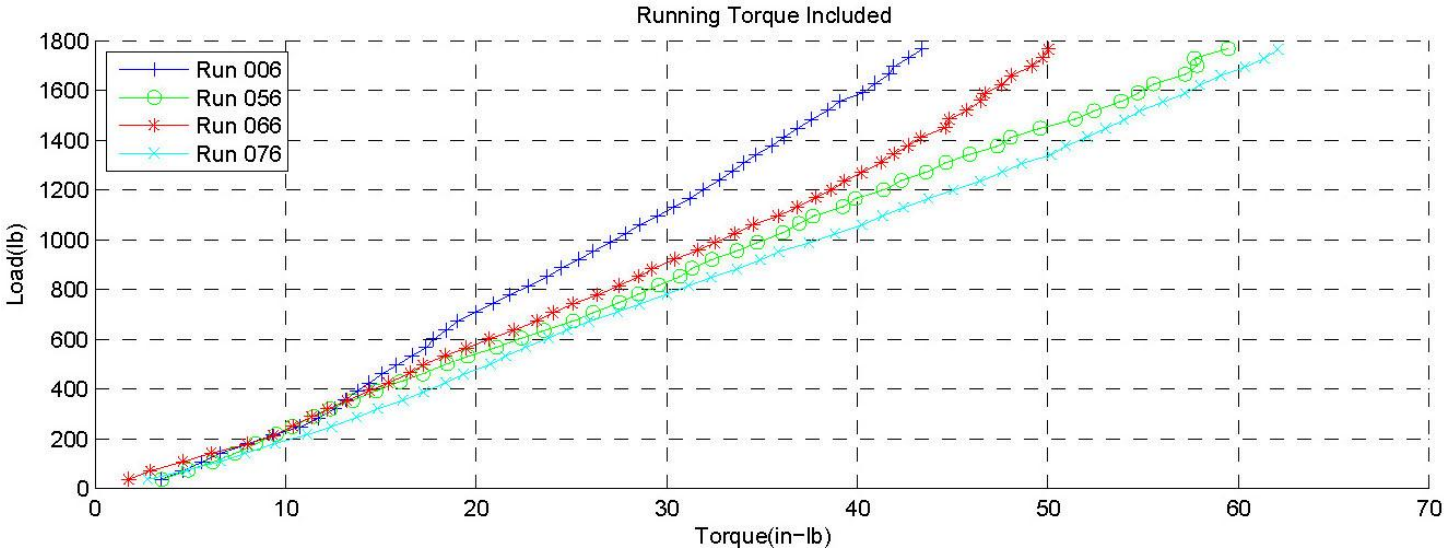

Torque vs. Load: Cycle No. 4
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & No Braycote; ExHD and/or HD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 004
Run 054
Run 064
Run 074
Load(lb)
Torque(in-lb)

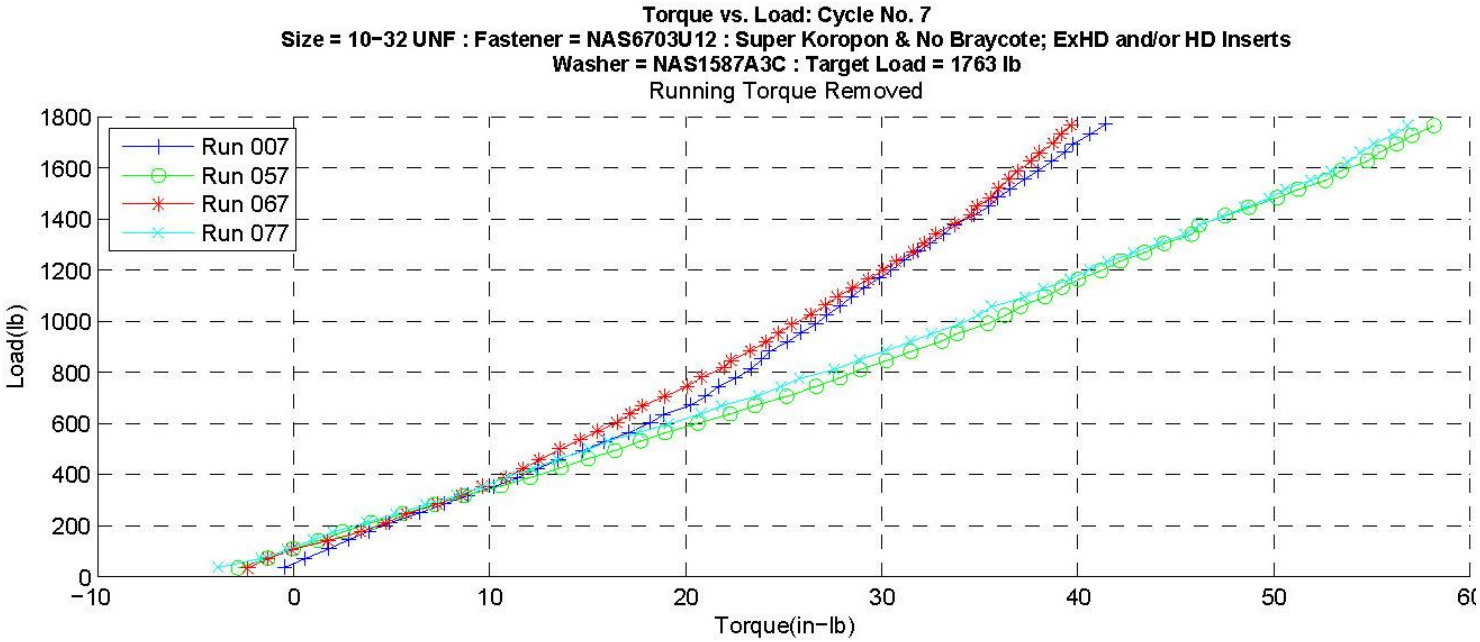

Running Torque Included
Run 004
Run 054
Run 064
Run 074
Load(lb)
Torque(in-lb)

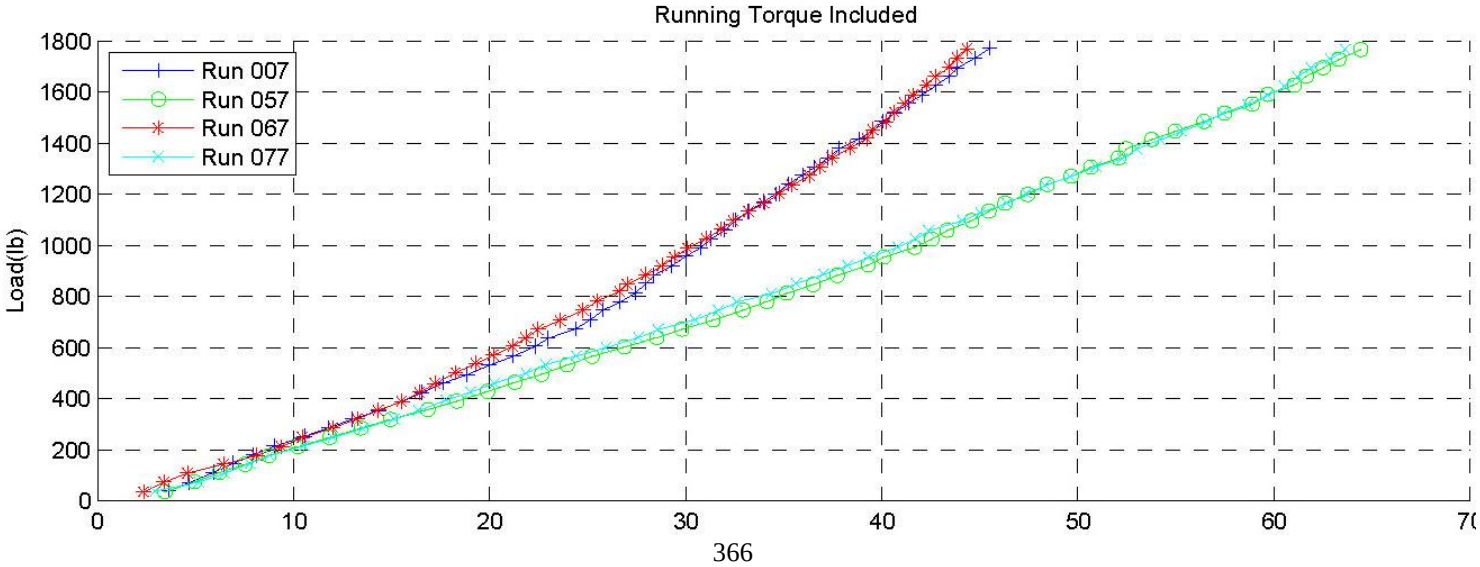

Torque vs. Load: Cycle No. 5
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & No Braycote; ExHD and/or HD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 005
Run 055
Run 065
Run 075
Load(lb)
Torque(in-lb)
0
200
400
600
800
1000
1200
1400
1600
1800
-10
0
10
20
30
40
50
60

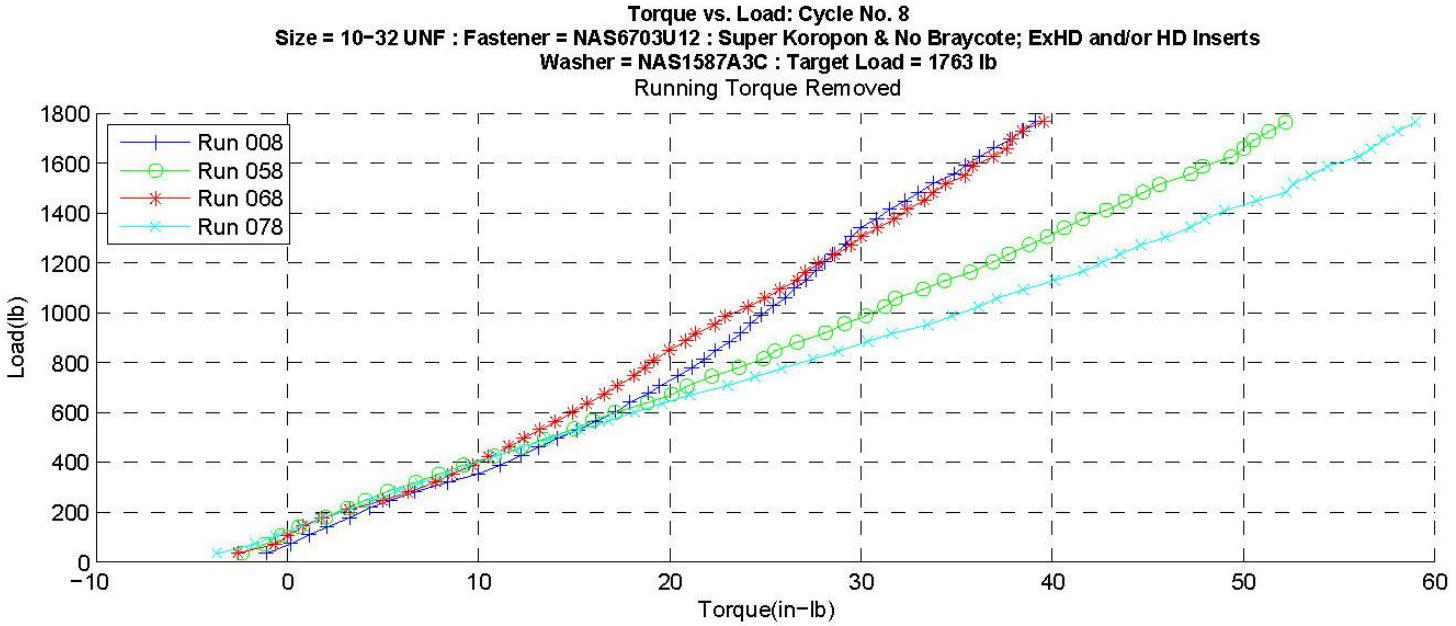

Running Torque Included
Run 005
Run 055
Run 065
Run 075
Load(lb)
Torque(in-lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
10
20
30
40
50
60
70

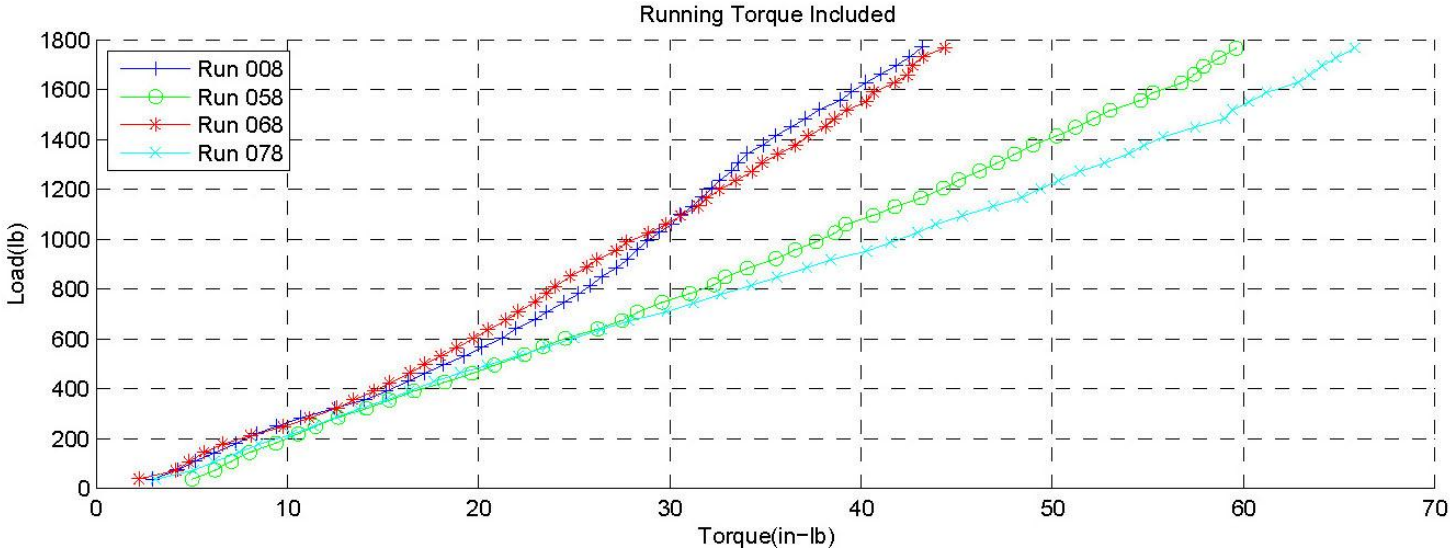

Torque vs. Load: Cycle No. 6
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & No Braycote; ExHD and/or HD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 006
Run 056
Run 066
Run 076
Load(lb)
Torque(in-lb)
0
200
400
600
800
1000
1200
1400
1600
1800
-10
0
10
20
30
40
50
60

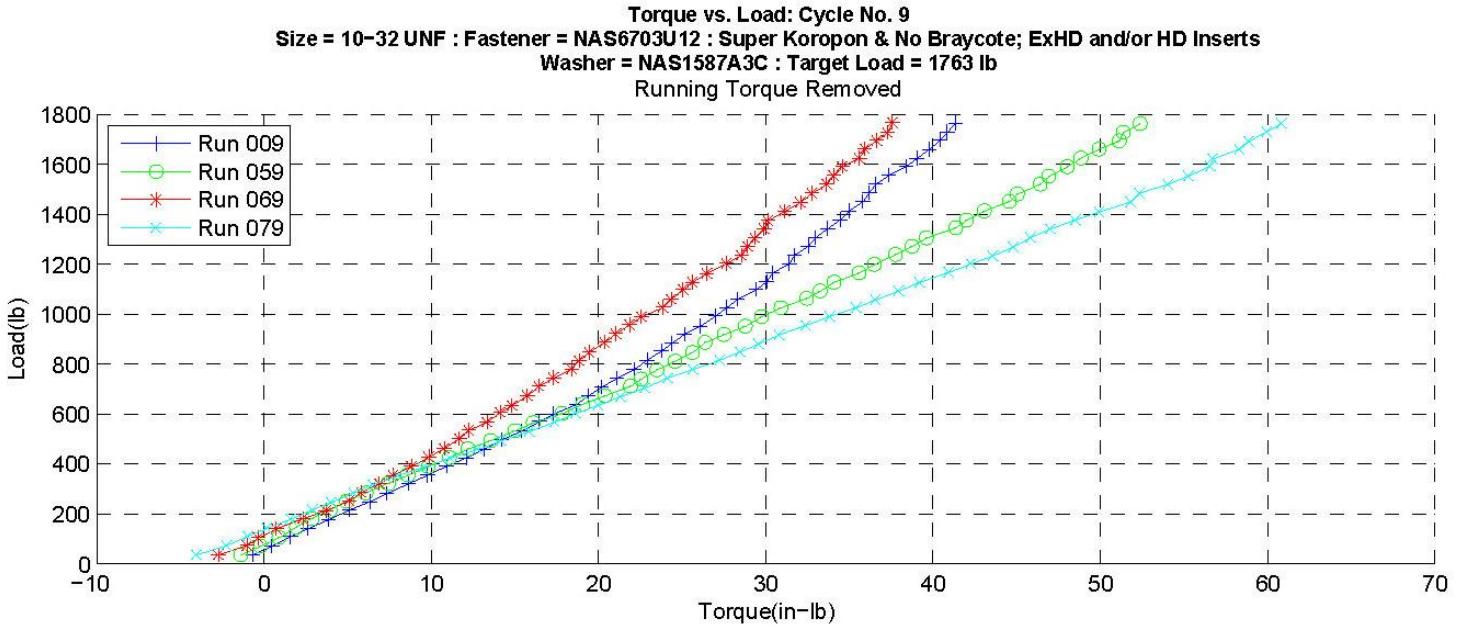

Running Torque Included
Run 006
Run 056
Run 066
Run 076
Load(lb)
Torque(in-lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
10
20
30
40
50
60
70

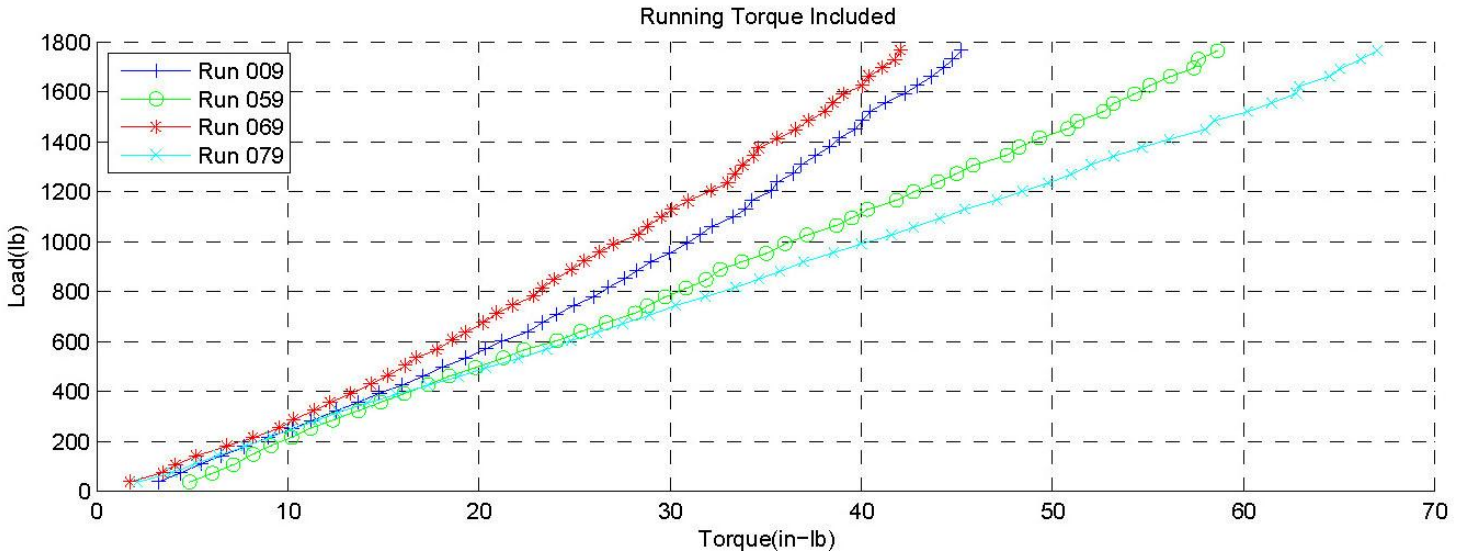

Torque vs. Load: Cycle No. 7
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & No Braycote; ExHD and/or HD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 007
Run 057
Run 067
Run 077
Load(lb)
Torque(in-lb)
0
200
400
600
800
1000
1200
1400
1600
1800
-10
0
10
20
30
40
50

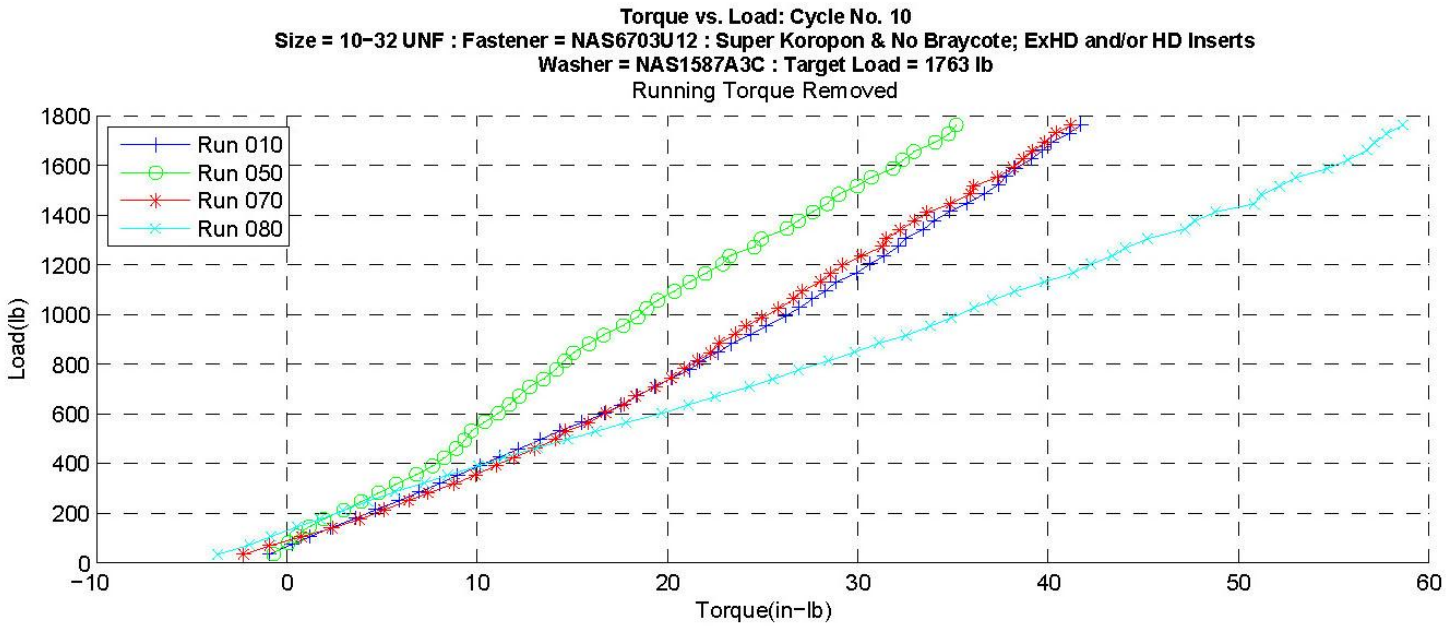

Running Torque Included
Run 007
Run 057
Run 067
Run 077
Load(lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
10
20
30
40
50
60

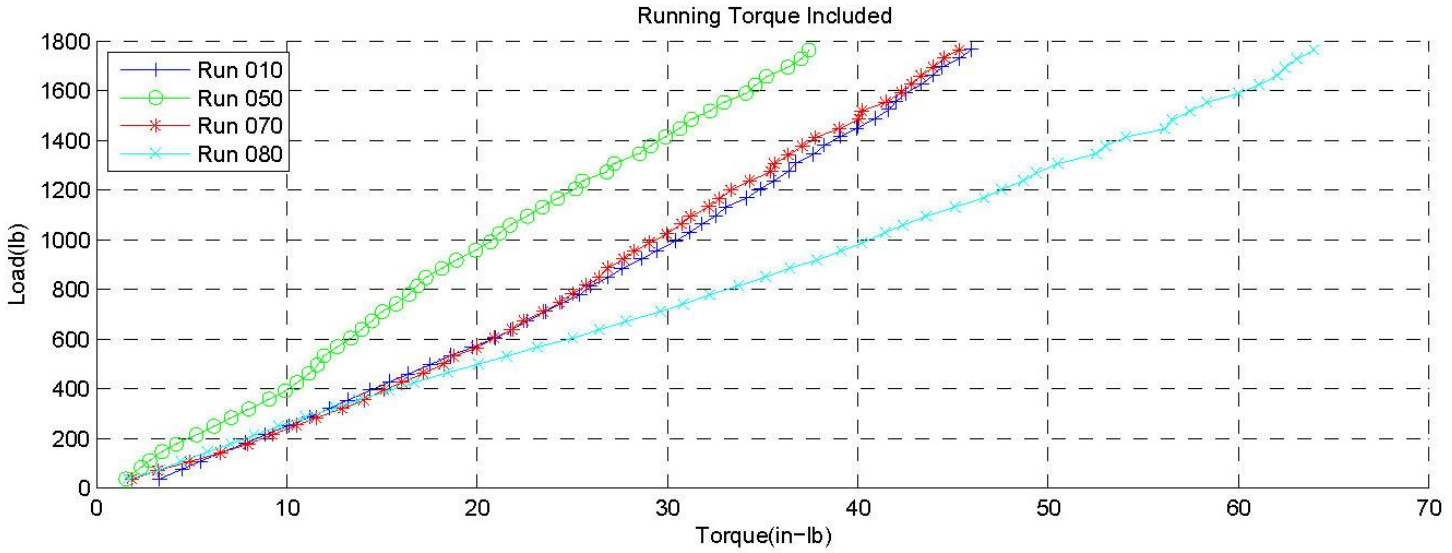

Torque vs. Load: Cycle No. 8
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & No Braycote; ExHD and/or HD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 008
Run 058
Run 068
Run 078
Load(lb)
Torque(in-lb)


Running Torque Included
Run 008
Run 058
Run 068
Run 078
Load(lb)
Torque(in-lb)


Torque vs. Load: Cycle No. 9
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & No Braycote; ExHD and/or HD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 009
Run 059
Run 069
Run 079
Load(lb)
Torque(in-lb)
0
200
400
600
800
1000
1200
1400
1600
1800
-10
0
10
20
30
40
50
60
70

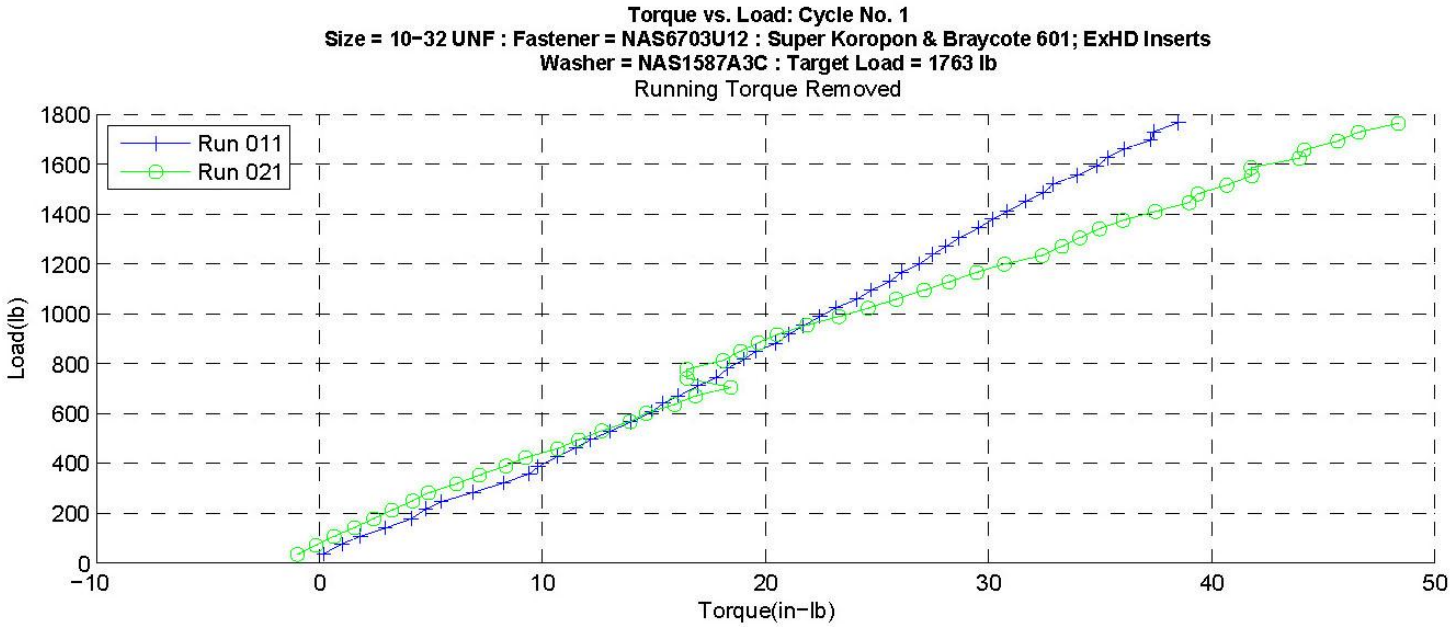

Running Torque Included
Run 009
Run 059
Run 069
Run 079
Load(lb)
Torque(in-lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
10
20
30
40
50
60
70

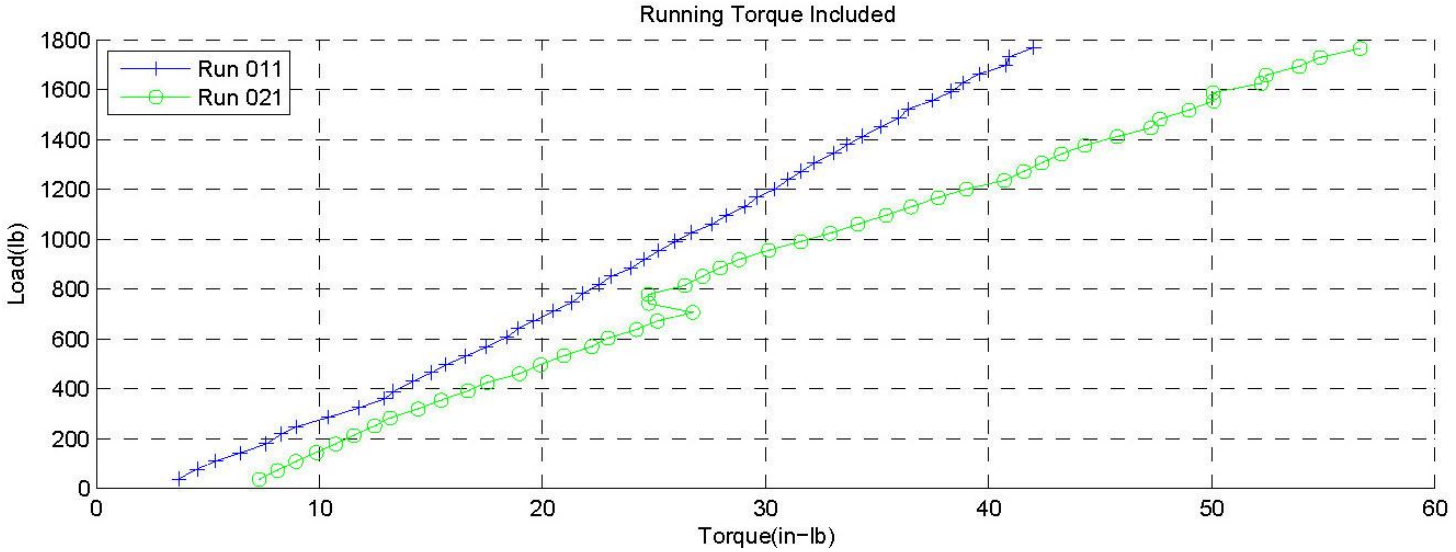

Torque vs. Load: Cycle No. 10
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & No Braycote; ExHD and/or HD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 010
Run 050
Run 070
Run 080
Load(lb)
Torque(in-lb)
0
200
400
600
800
1000
1200
1400
1600
1800
-10
0
10
20
30
40
50
60

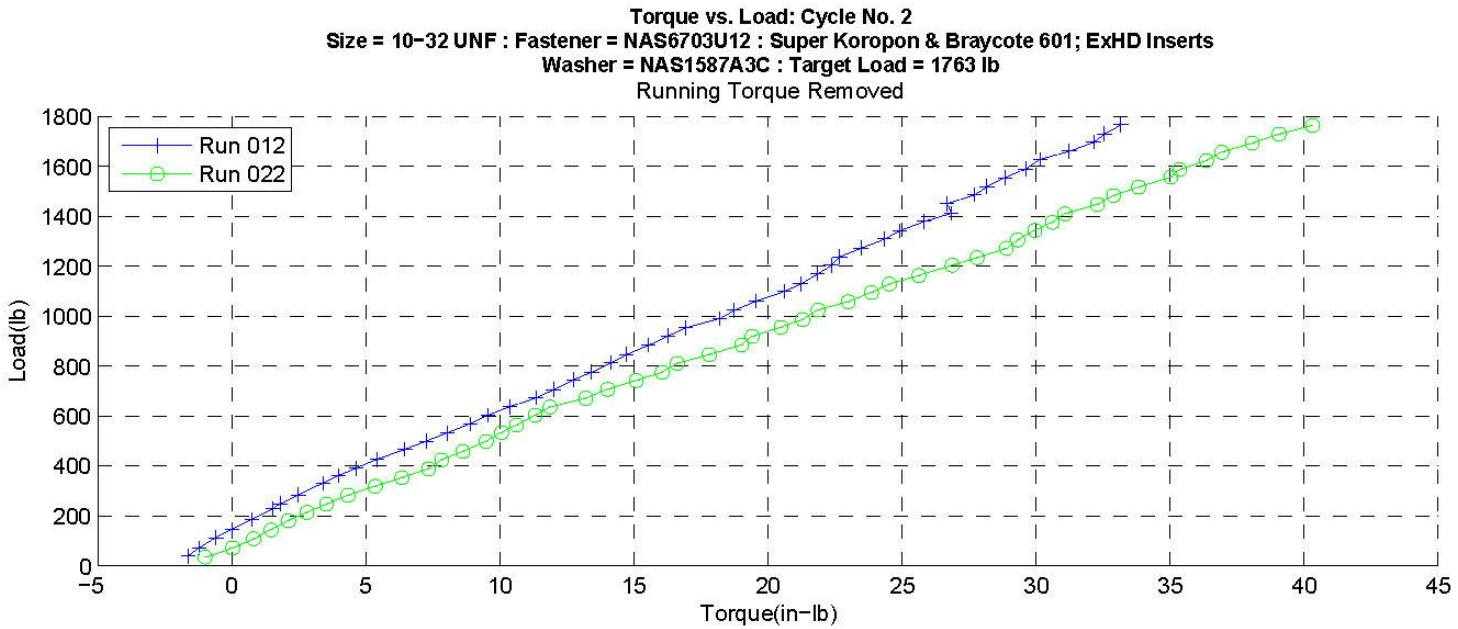

Running Torque Included
Run 010
Run 050
Run 070
Run 080
Load(lb)
Torque(in-lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
10
20
30
40
50
60
70

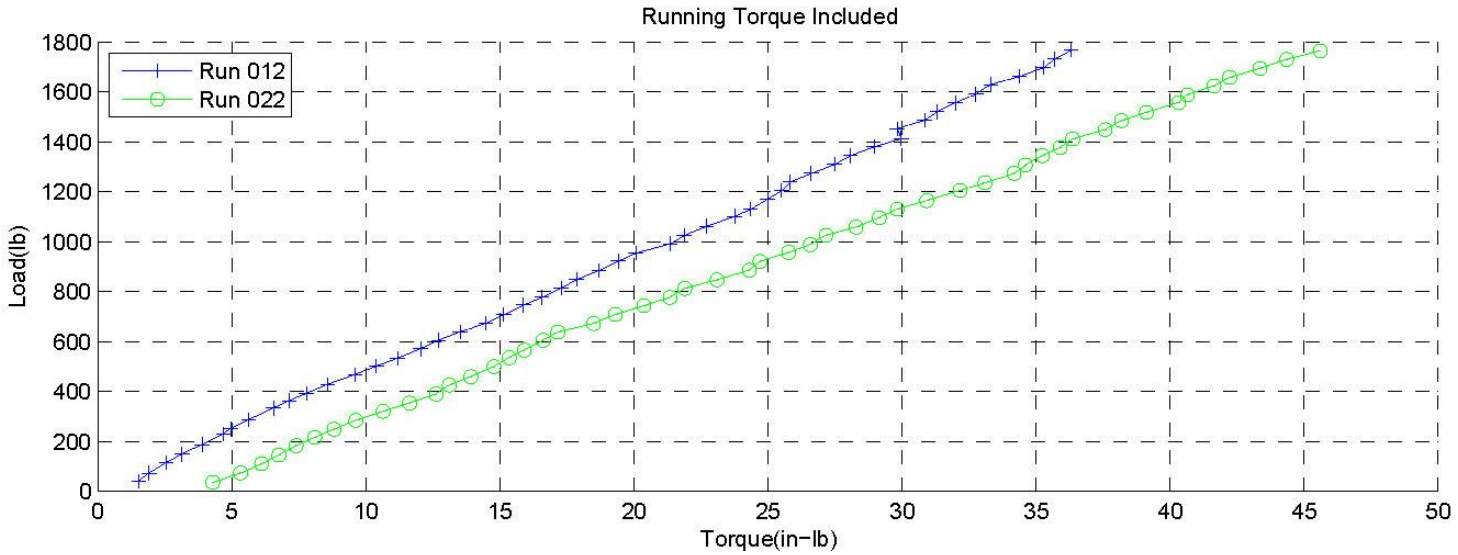
Appendix C:

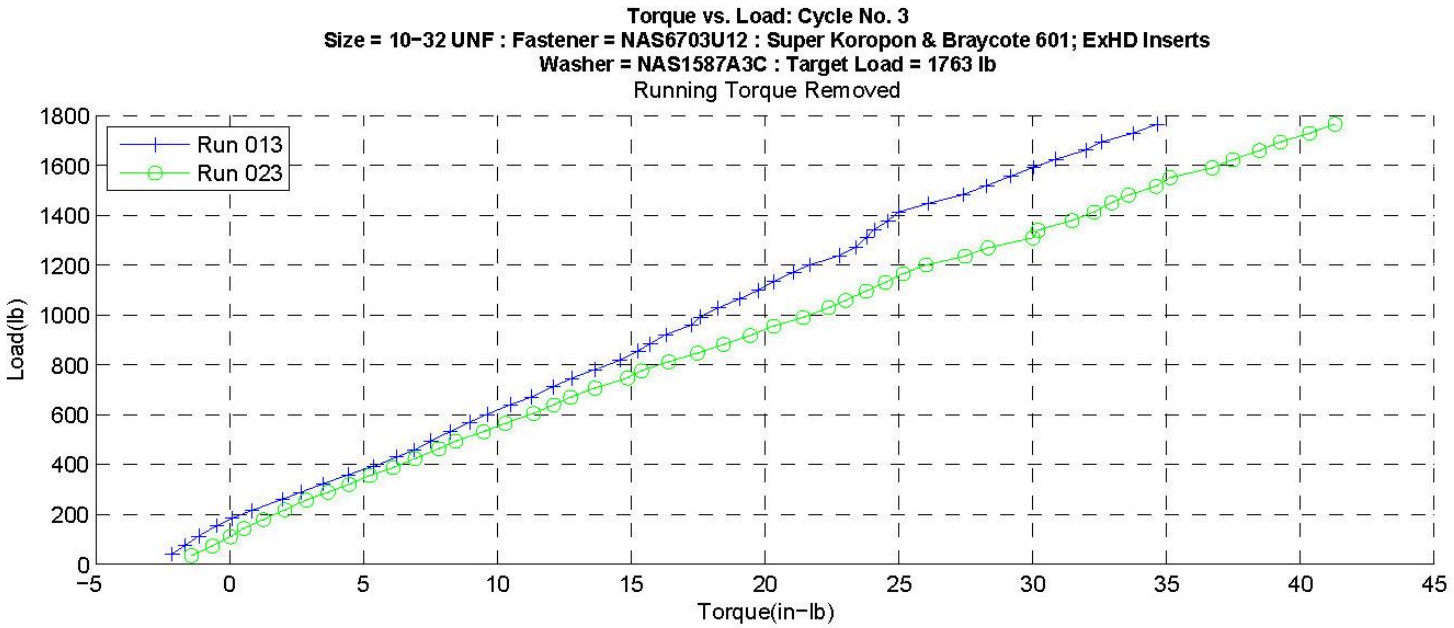
Section 1	10-32 No Braycote Torque Tension Plots
Section 2	10-32 Braycote 601 Torque Tension Plots
Section 3	10-32 Braycote 602 Torque Tension Plots
Section 4	10-32 No Braycote Running Torque Plots
Section 5	10-32 Braycote 601 Running Torque Plots
Section 6	10-32 Braycote 602 Running Torque Plots
Section 7	10-32 No Braycote Cycle Plots: Torque v. Load
Section 8	10-32 Braycote 601 Cycle Plots: Torque v. Load
Section 9	10-32 Braycote 602 Cycle Plots: Torque v. Load
Section 10	10-32 Friction Coefficients with Statistics
Section 11	10-32 Test Plate Layouts
Section 12	10-32 No Braycote Run Log
Section 13	10-32 Braycote 601 Run Logs
Section 14	10-32 Braycote 602 Run Logs

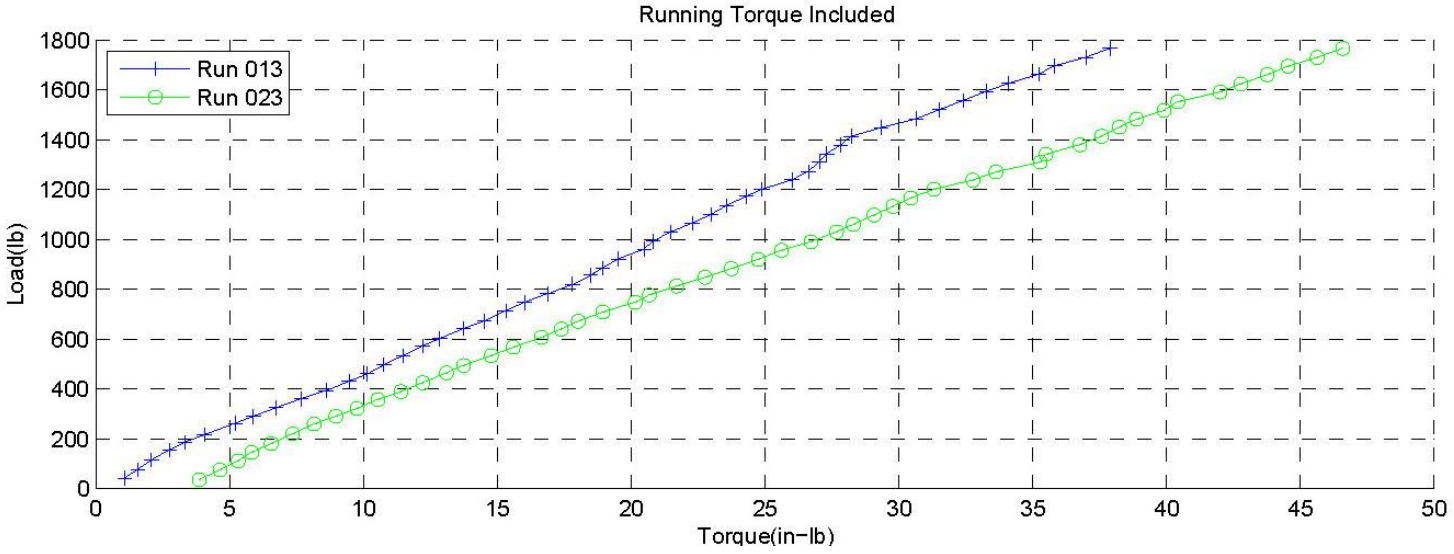

Torque vs. Load: Cycle No. 1
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & Braycote 601; ExHD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 011
Run 021
Load(lb)
Torque(in-lb)
0
200
400
600
800
1000
1200
1400
1600
1800
-10
0
10
20
30
40
50

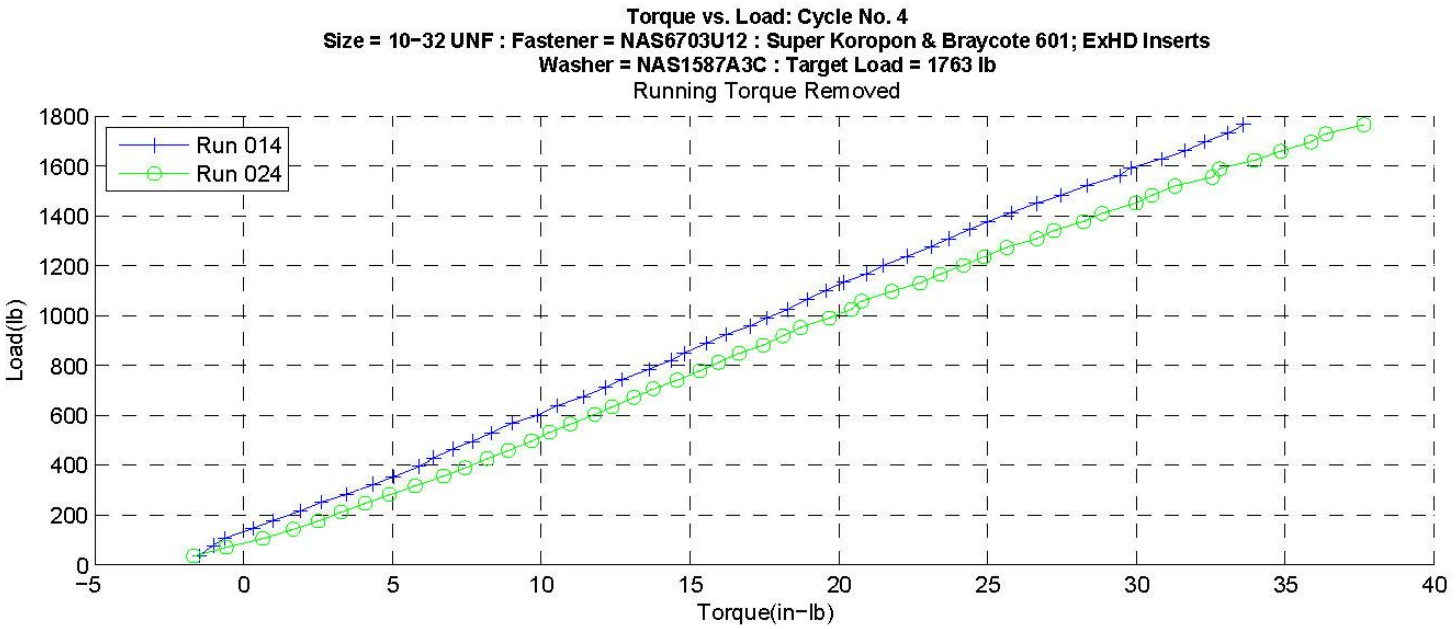

Running Torque Included
Run 011
Run 021
Load(lb)
Torque(in-lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
10
20
30
40
50
60

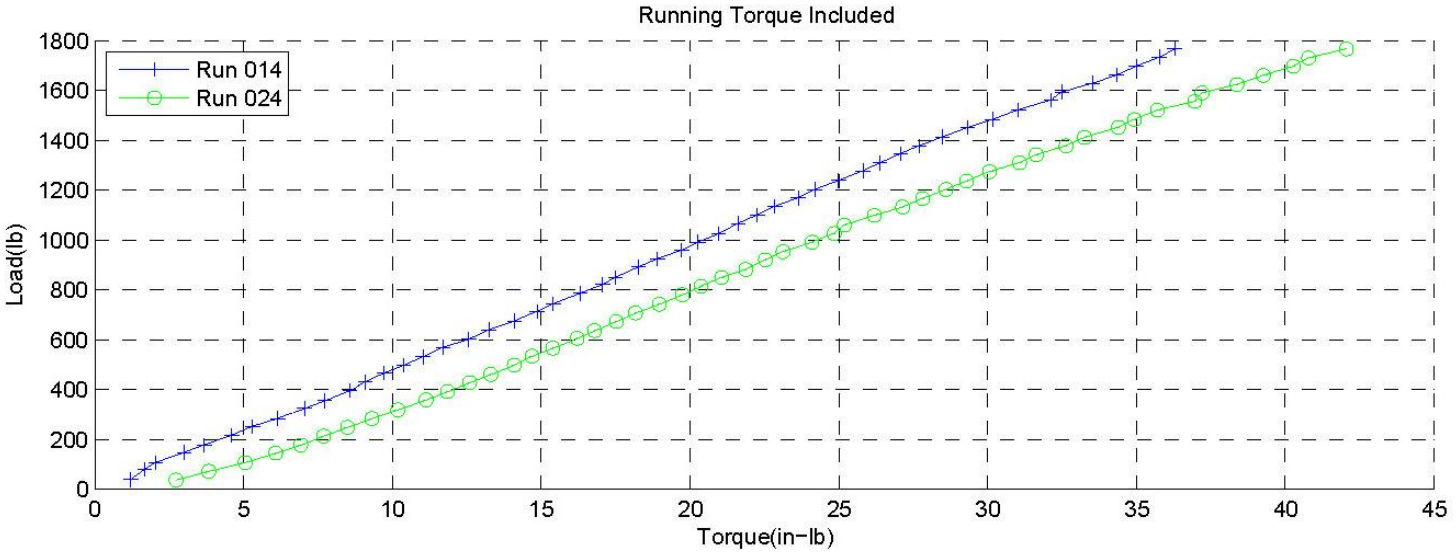

Torque vs. Load: Cycle No. 2
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & Braycote 601; ExHD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 012
Run 022
Load(lb)
Torque(in-lb)

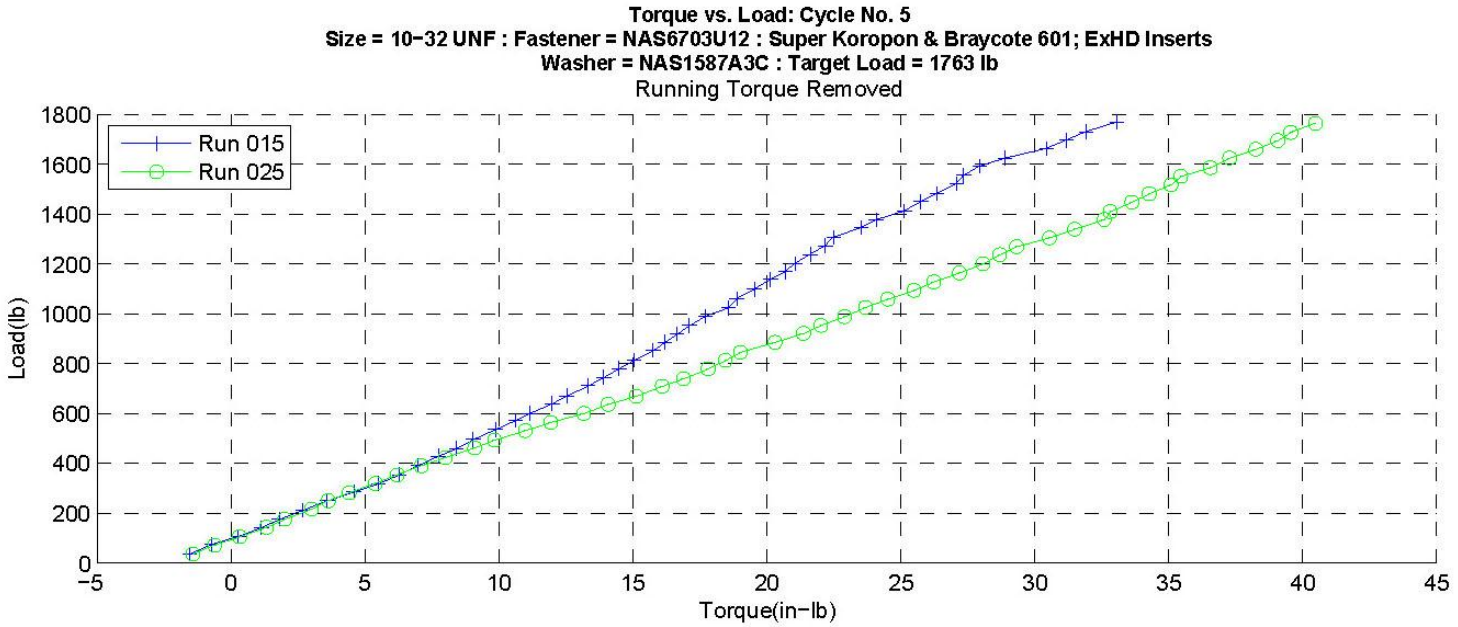

Running Torque Included
Run 012
Run 022
Load(lb)
Torque(in-lb)

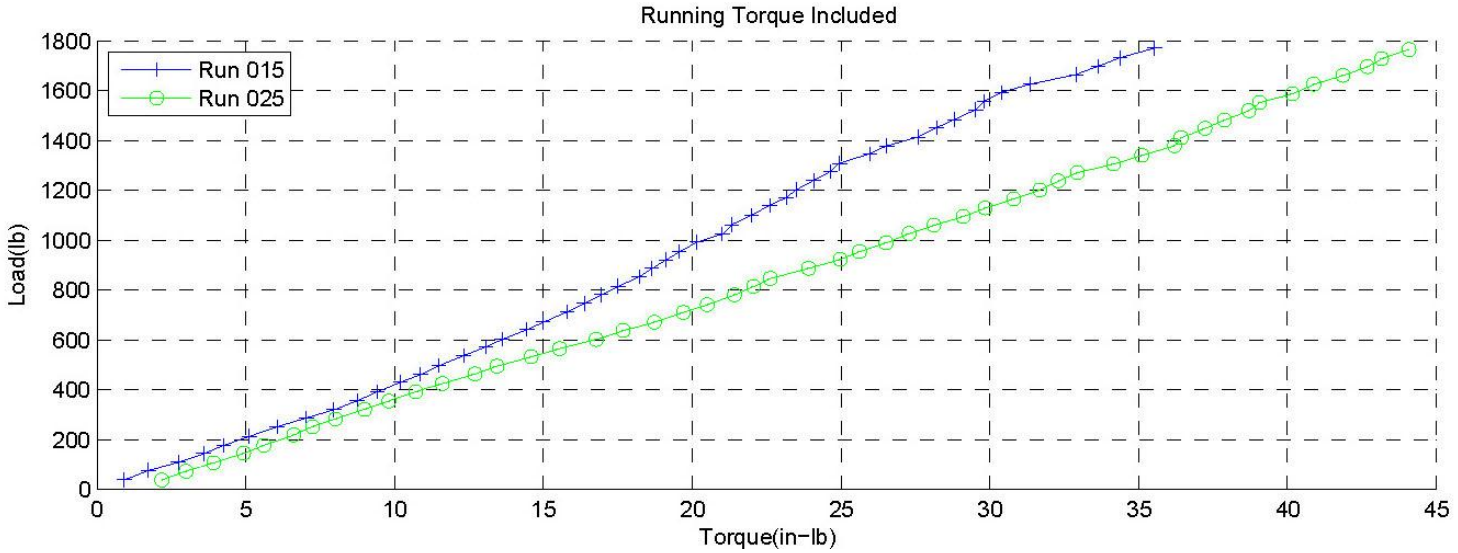

Torque vs. Load: Cycle No. 3
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & Braycote 601; ExHD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 013
Run 023
Load(lb)
Torque(in-lb)

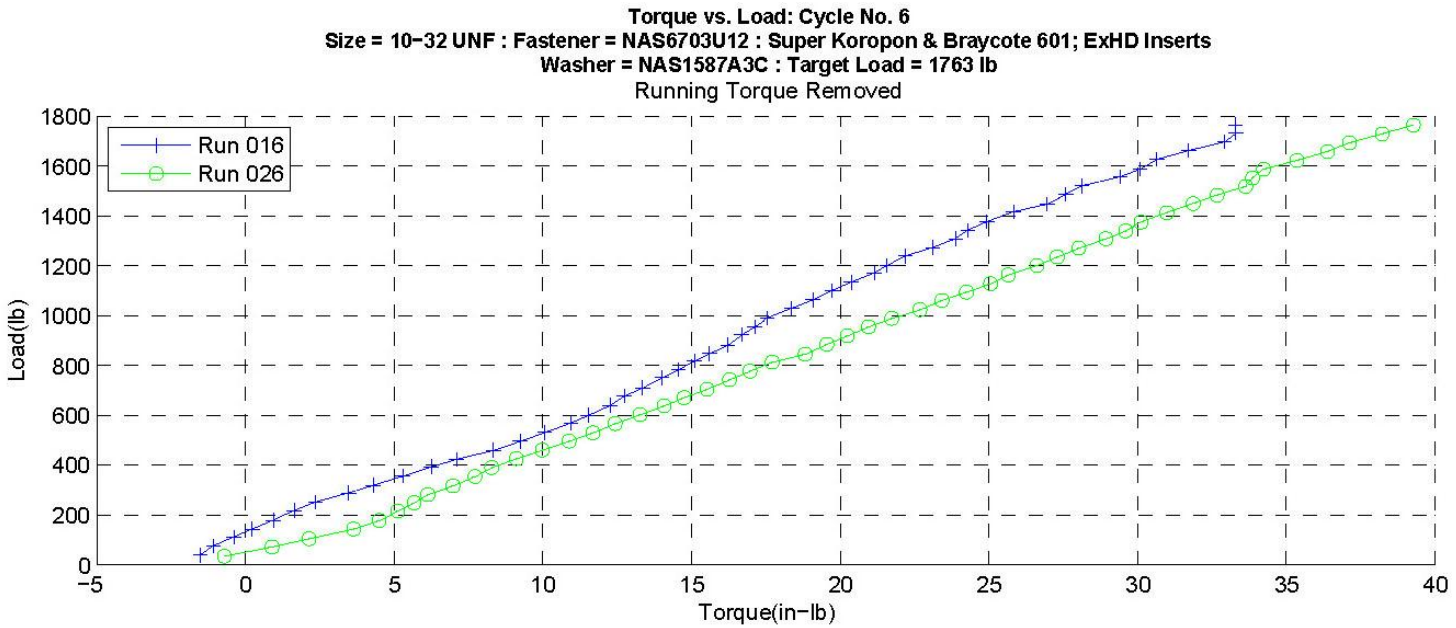

Running Torque Included
Run 013
Run 023
Load(lb)
Torque(in-lb)

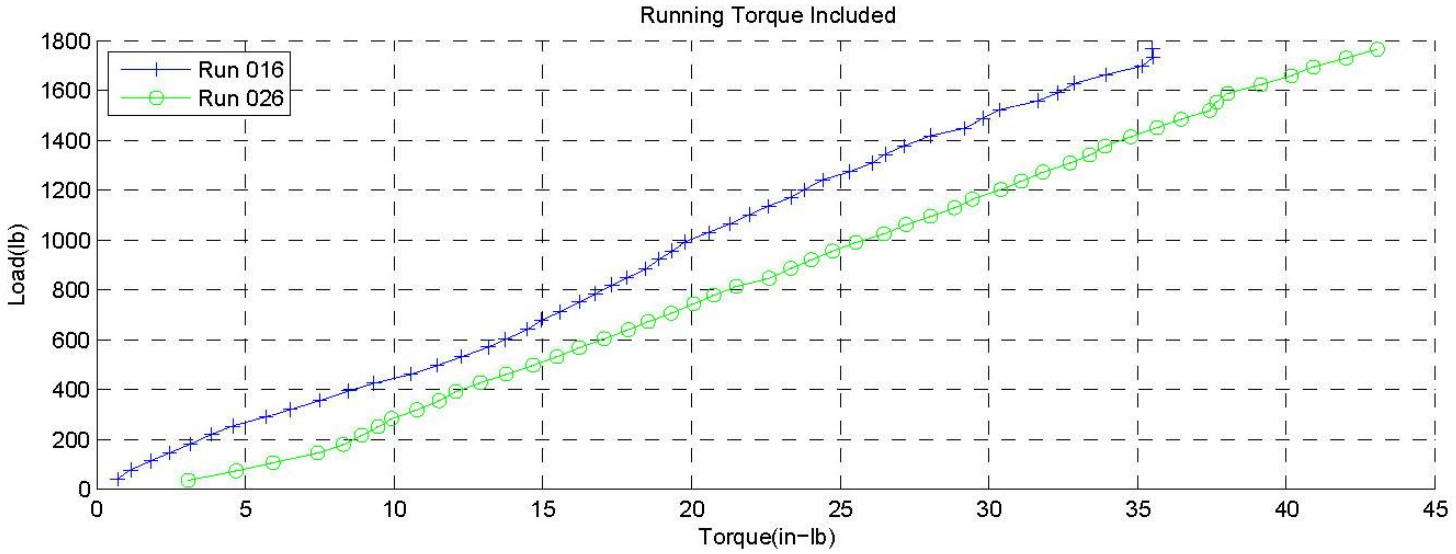

Torque vs. Load: Cycle No. 4
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & Braycote 601; ExHD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 014
Run 024
Load(lb)
Torque(in-lb)

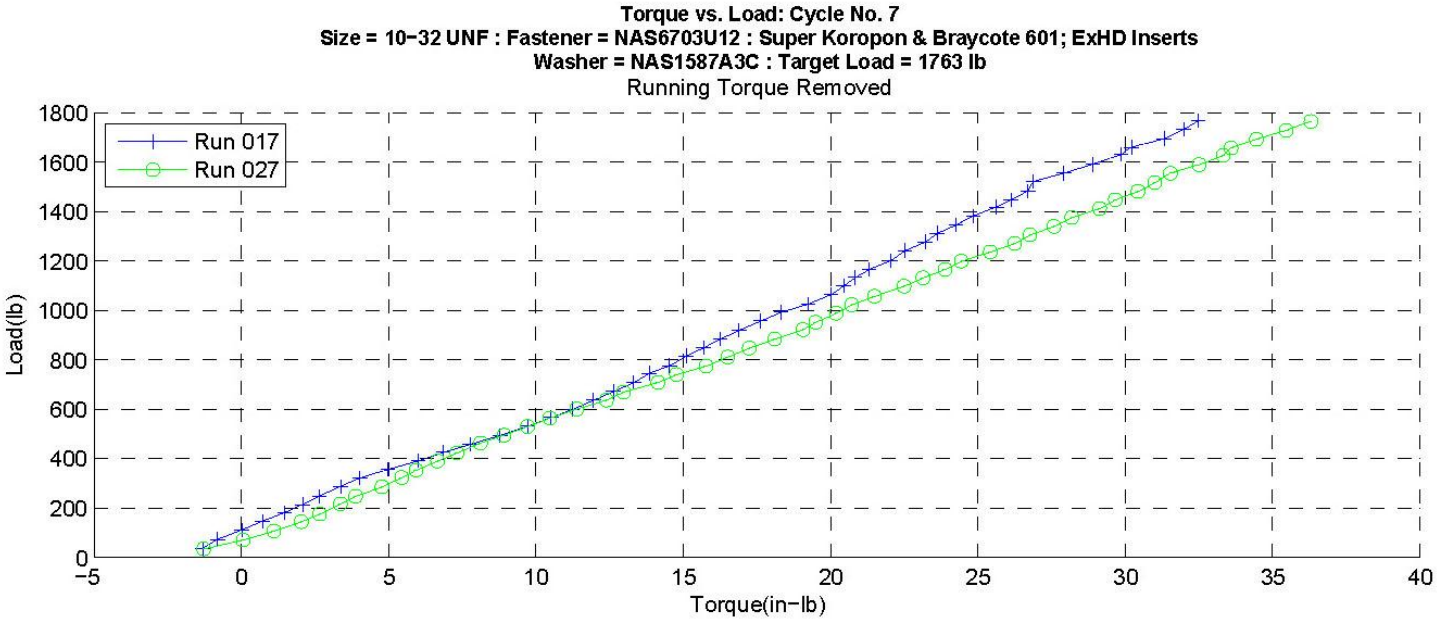

Running Torque Included
Run 014
Run 024
Load(lb)
Torque(in-lb)

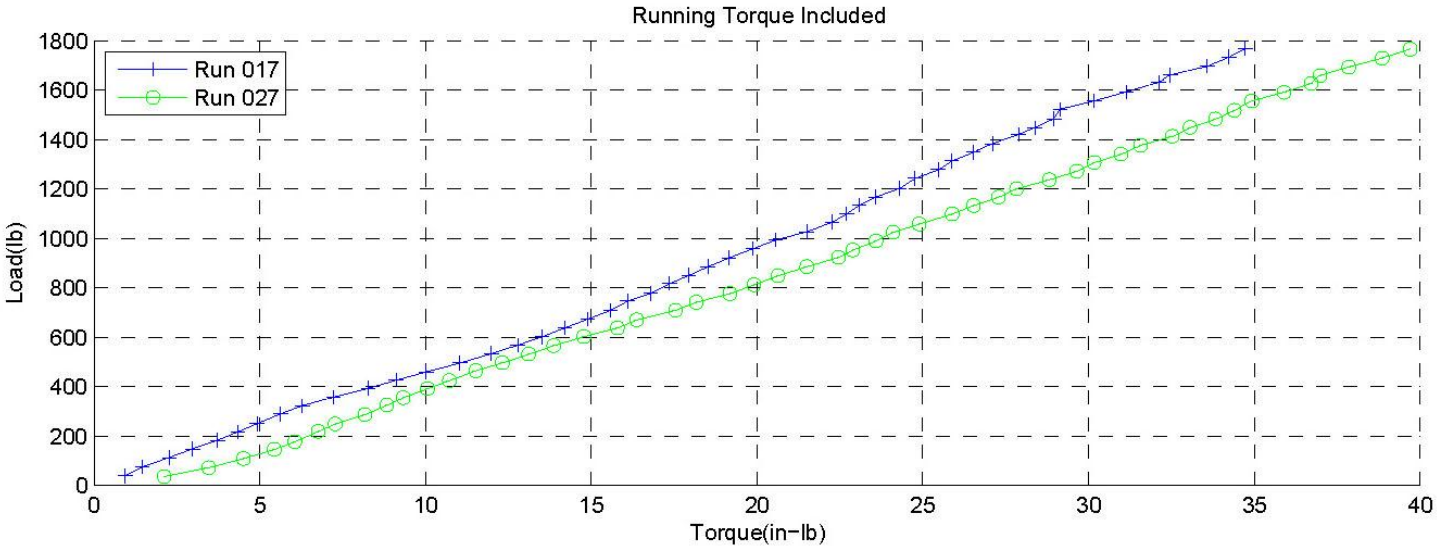

Torque vs. Load: Cycle No. 5
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & Braycote 601; ExHD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 015
Run 025
Load(lb)
Torque(in-lb)

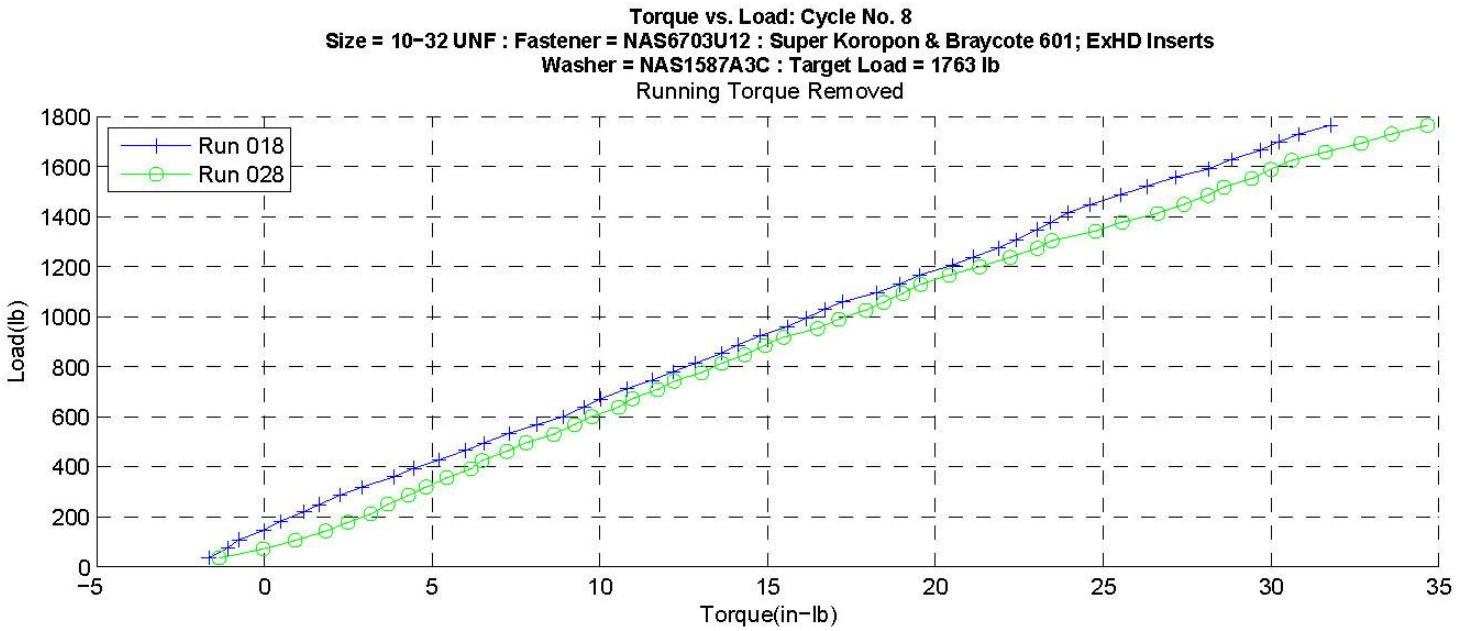

Running Torque Included
Run 015
Run 025
Load(lb)
Torque(in-lb)

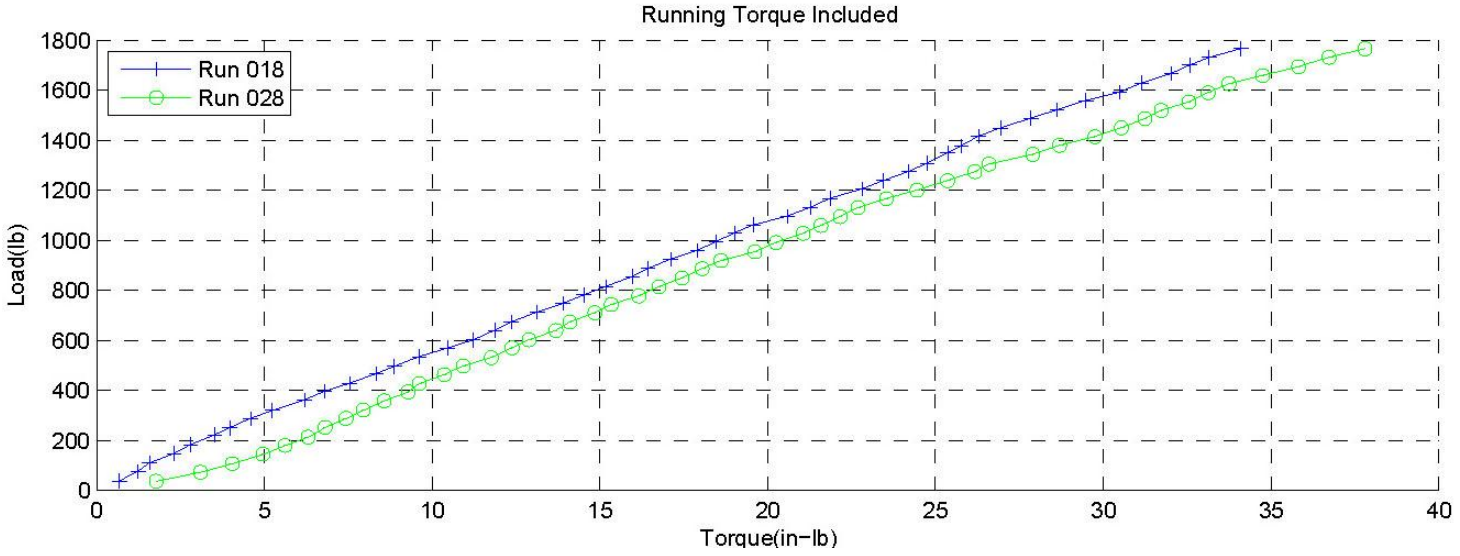

Torque vs. Load: Cycle No. 6
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & Braycote 601; ExHD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 016
Run 026
Load(lb)
Torque(in-lb)

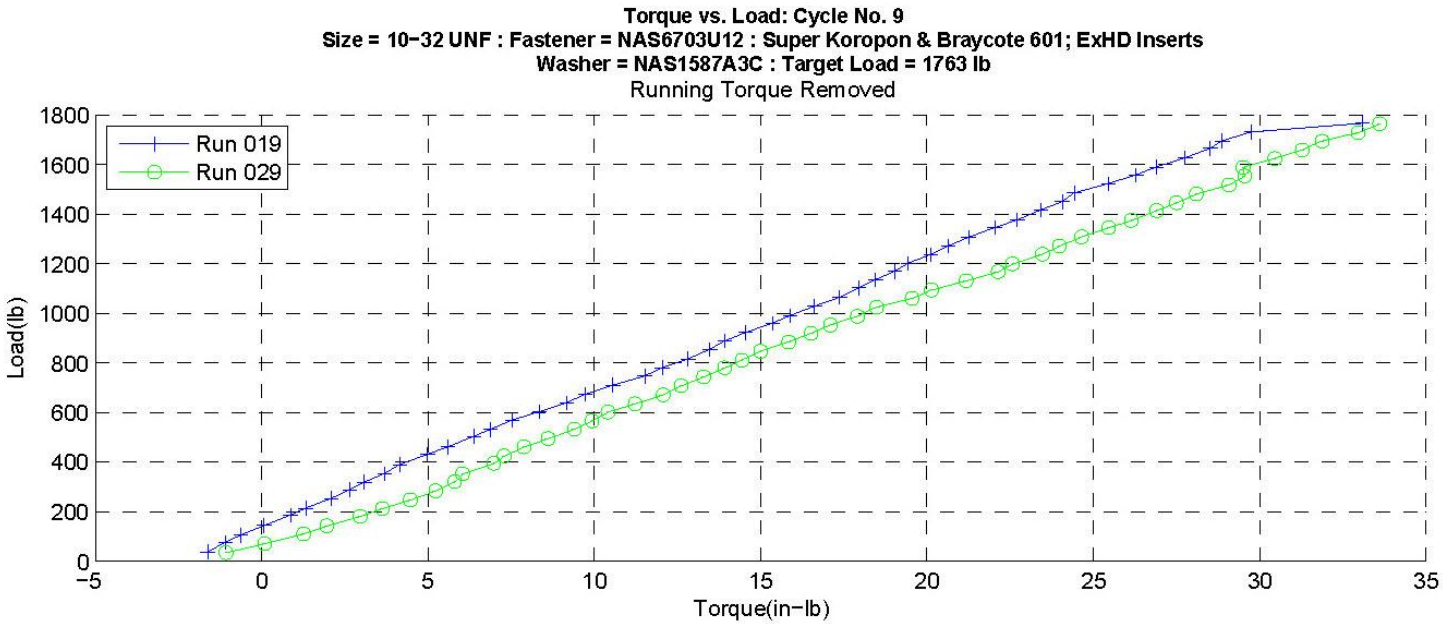

Running Torque Included
Run 016
Run 026
Load(lb)
Torque(in-lb)

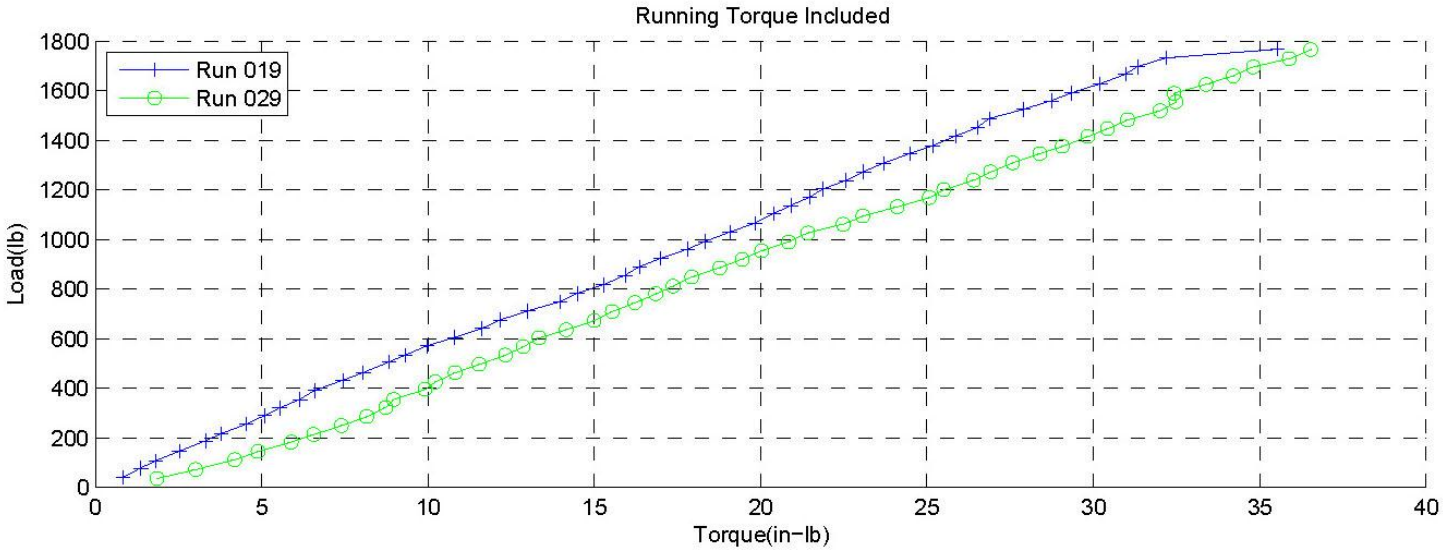

Torque vs. Load: Cycle No. 7
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & Braycote 601; ExHD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 017
Run 027
Load(lb)
Torque(in-lb)
0
200
400
600
800
1000
1200
1400
1600
1800
-5
0
5
10
15
20
25
30
35
40

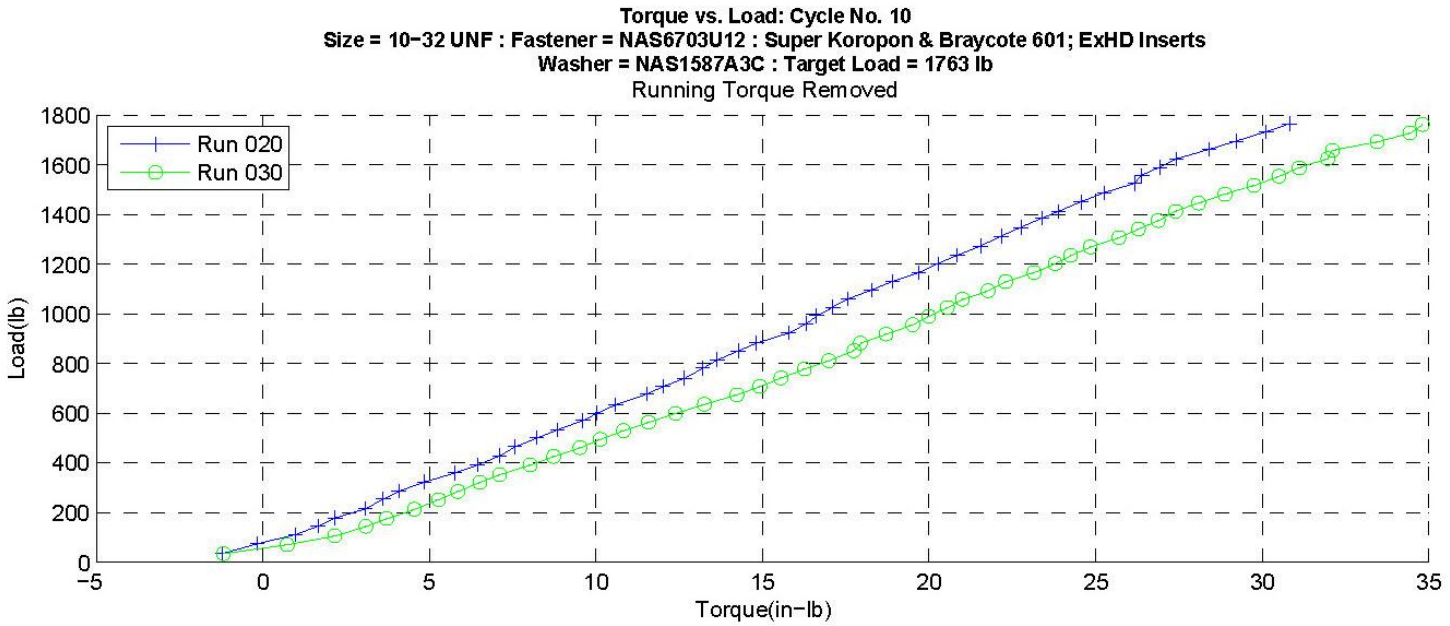

Running Torque Included
Run 017
Run 027
Load(lb)
Torque(in-lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
5
10
15
20
25
30
35
40

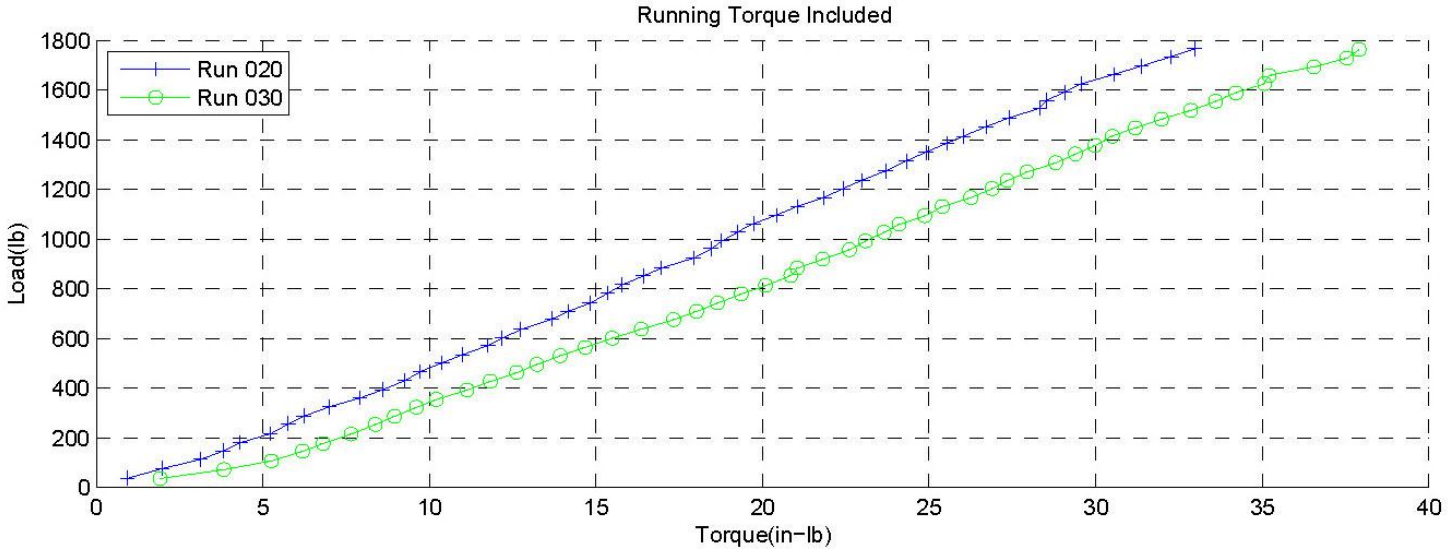

Torque vs. Load: Cycle No. 8
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & Braycote 601; ExHD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 018
Run 028
Load(lb)
Torque(in-lb)
0
200
400
600
800
1000
1200
1400
1600
1800
-5
0
5
10
15
20
25
30
35


Running Torque Included
Run 018
Run 028
Load(lb)
Torque(in-lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
5
10
15
20
25
30
35
40


Torque vs. Load: Cycle No. 9
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & Braycote 601; ExHD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 019
Run 029
Load(lb)
Torque(in-lb)
0
200
400
600
800
1000
1200
1400
1600
1800
-5
0
5
10
15
20
25
30
35

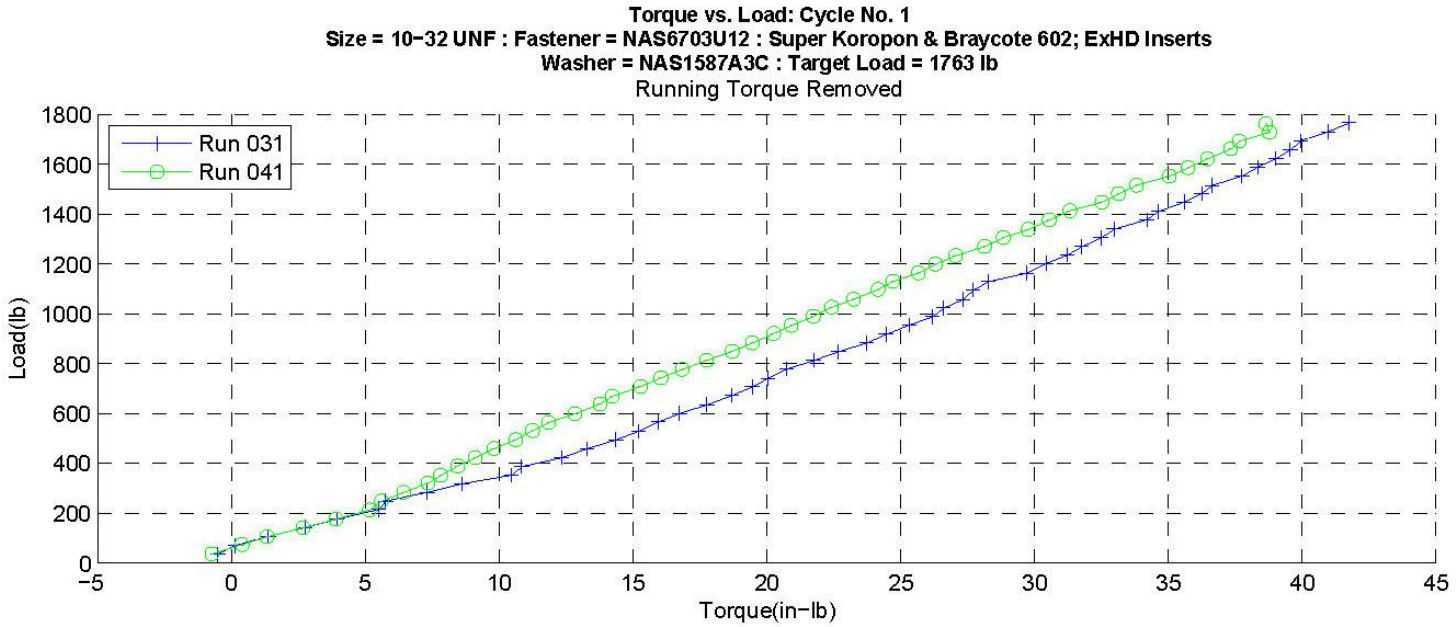

Running Torque Included
Run 019
Run 029
Load(lb)
Torque(in-lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
5
10
15
20
25
30
35
40

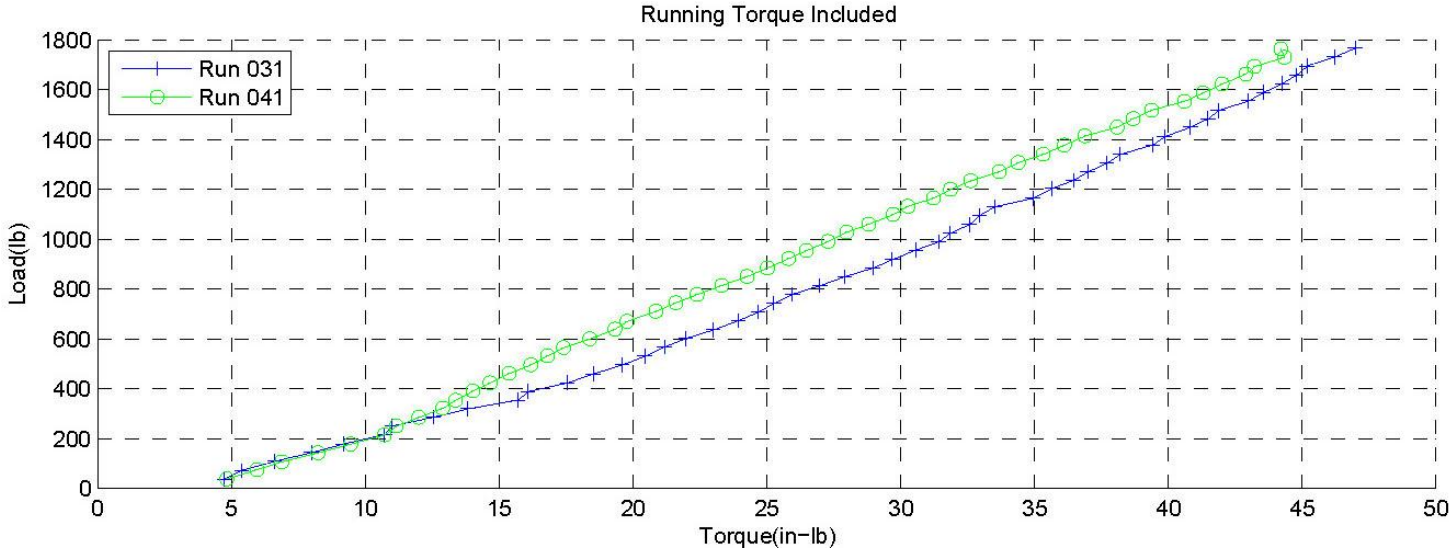

Torque vs. Load: Cycle No. 10
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & Braycote 601; ExHD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 020
Run 030
Load(lb)
Torque(in-lb)
0
200
400
600
800
1000
1200
1400
1600
1800
-5
0
5
10
15
20
25
30
35

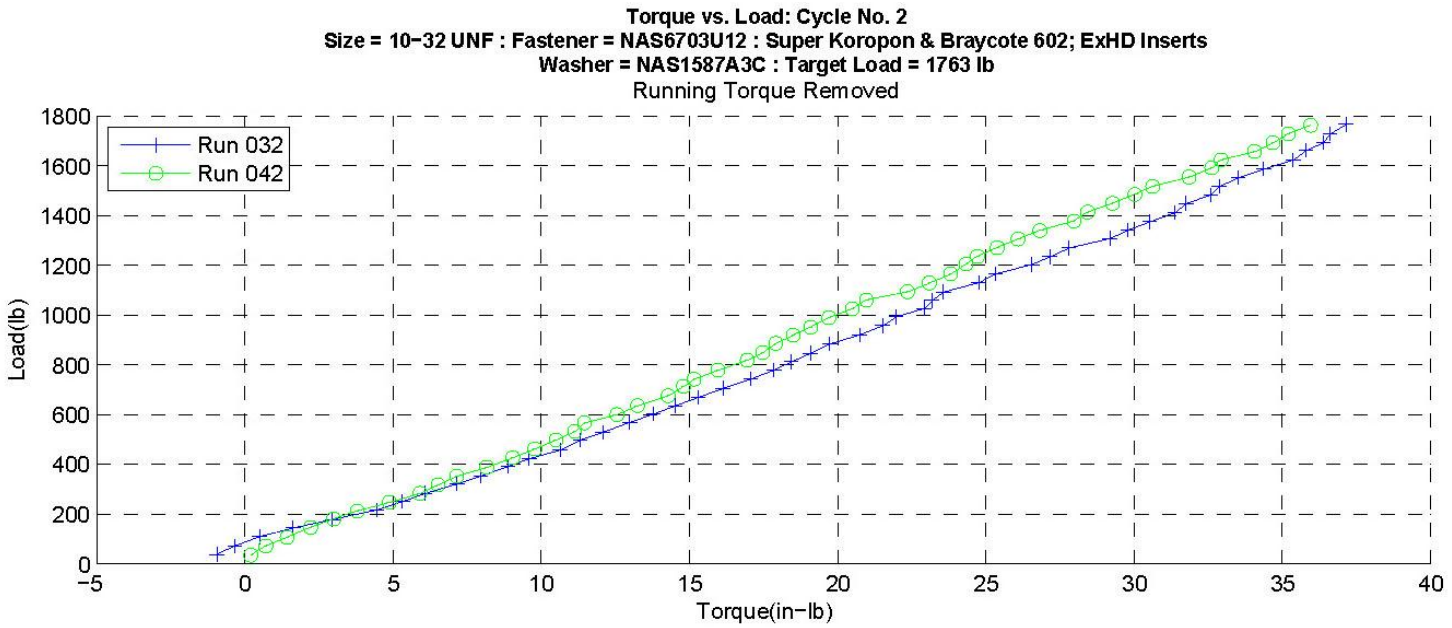

Running Torque Included
Run 020
Run 030
Load(lb)
Torque(in-lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
5
10
15
20
25
30
35
40

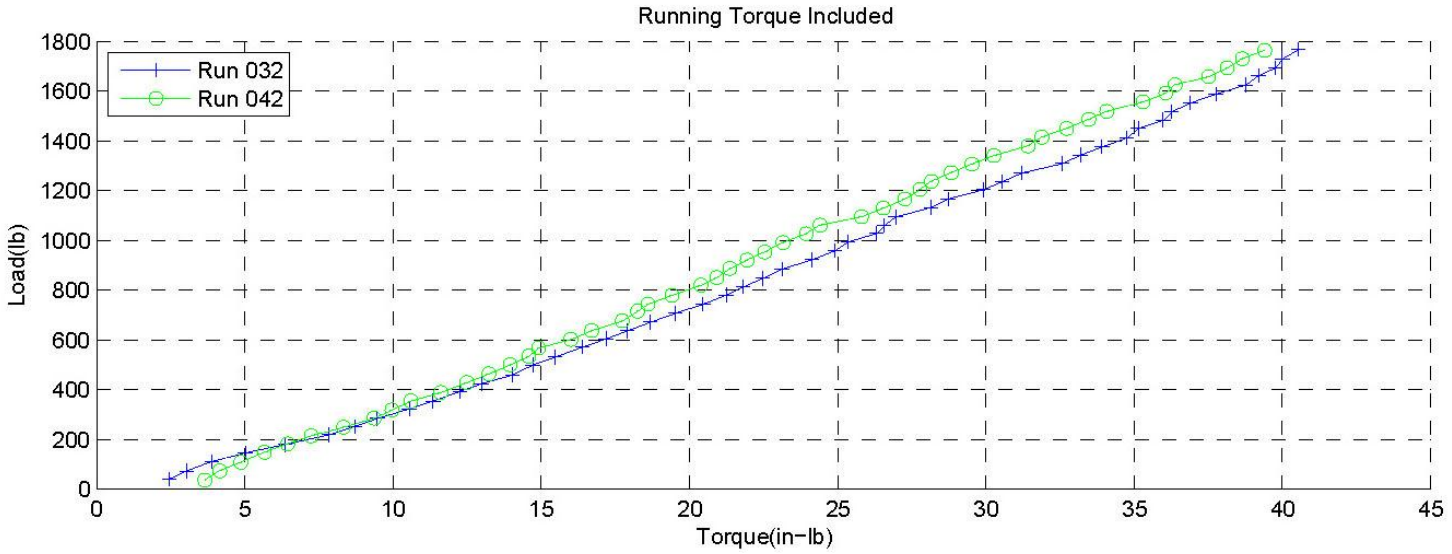
Appendix C:

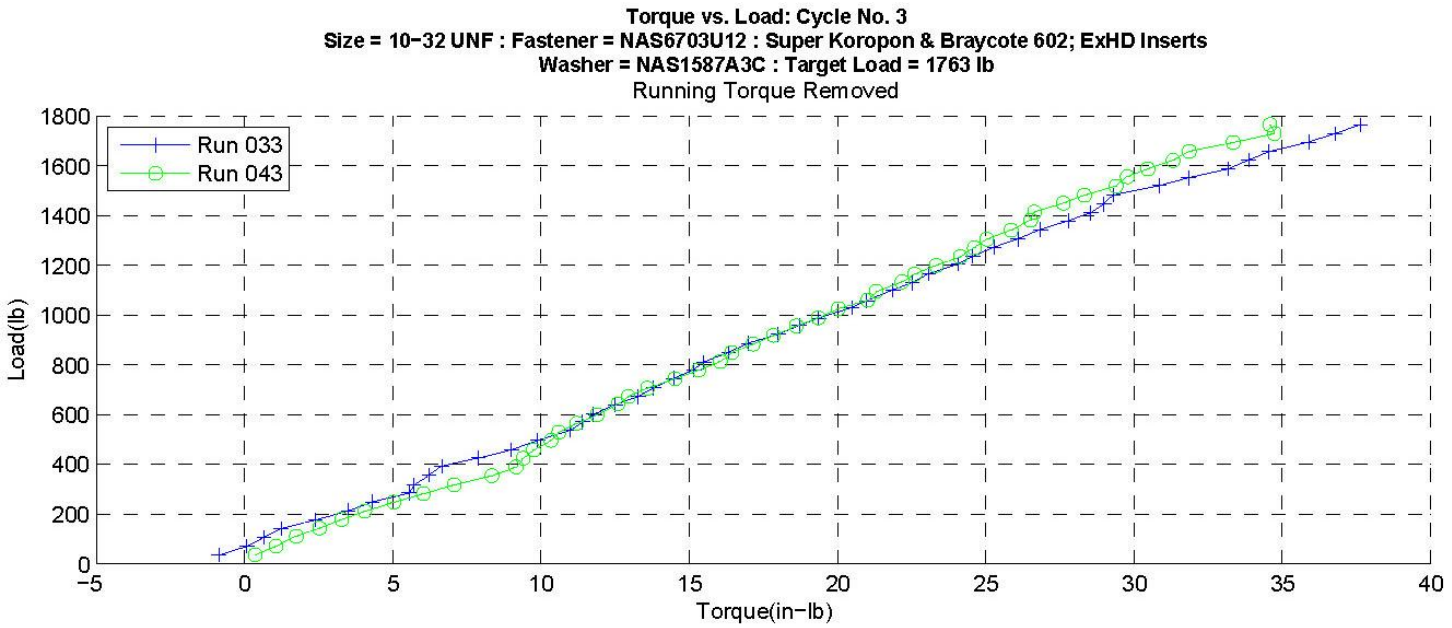
Section 1	10-32 No Braycote Torque Tension Plots
Section 2	10-32 Braycote 601 Torque Tension Plots
Section 3	10-32 Braycote 602 Torque Tension Plots
Section 4	10-32 No Braycote Running Torque Plots
Section 5	10-32 Braycote 601 Running Torque Plots
Section 6	10-32 Braycote 602 Running Torque Plots
Section 7	10-32 No Braycote Cycle Plots: Torque v. Load
Section 8	10-32 Braycote 601 Cycle Plots: Torque v. Load
Section 9	10-32 Braycote 602 Cycle Plots: Torque v. Load
Section 10	10-32 Friction Coefficients with Statistics
Section 11	10-32 Test Plate Layouts
Section 12	10-32 No Braycote Run Log
Section 13	10-32 Braycote 601 Run Logs
Section 14	10-32 Braycote 602 Run Logs

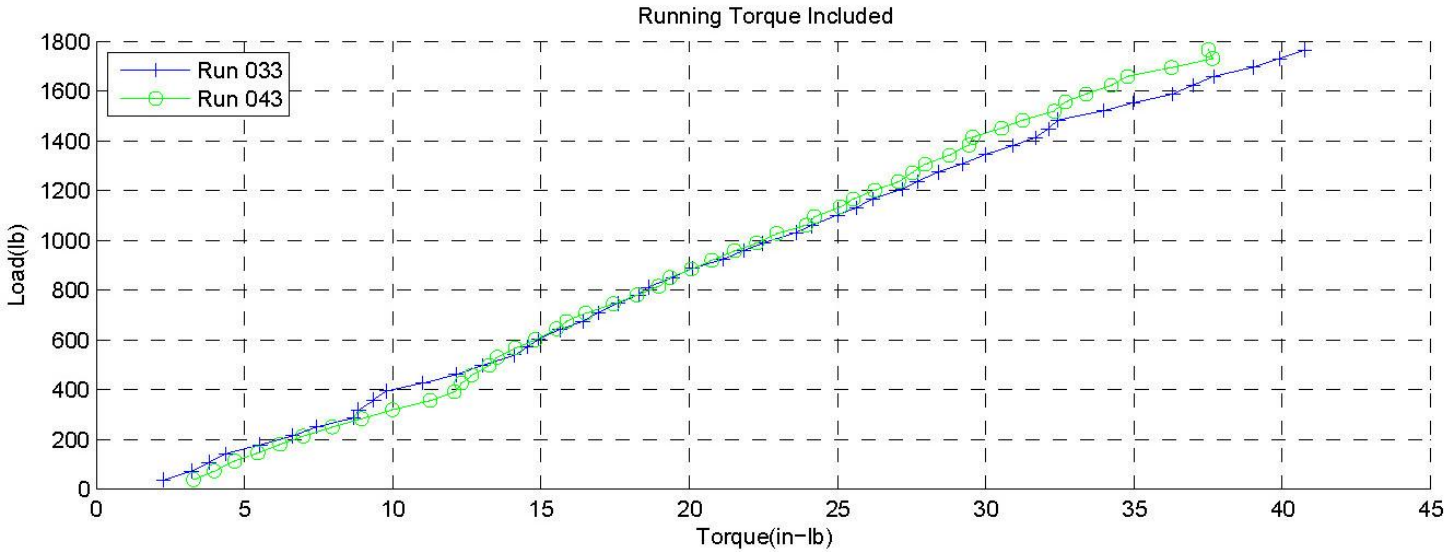

Torque vs. Load: Cycle No. 1
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & Braycote 602; ExHD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 031
Run 041
Load(lb)
Torque(in-lb)

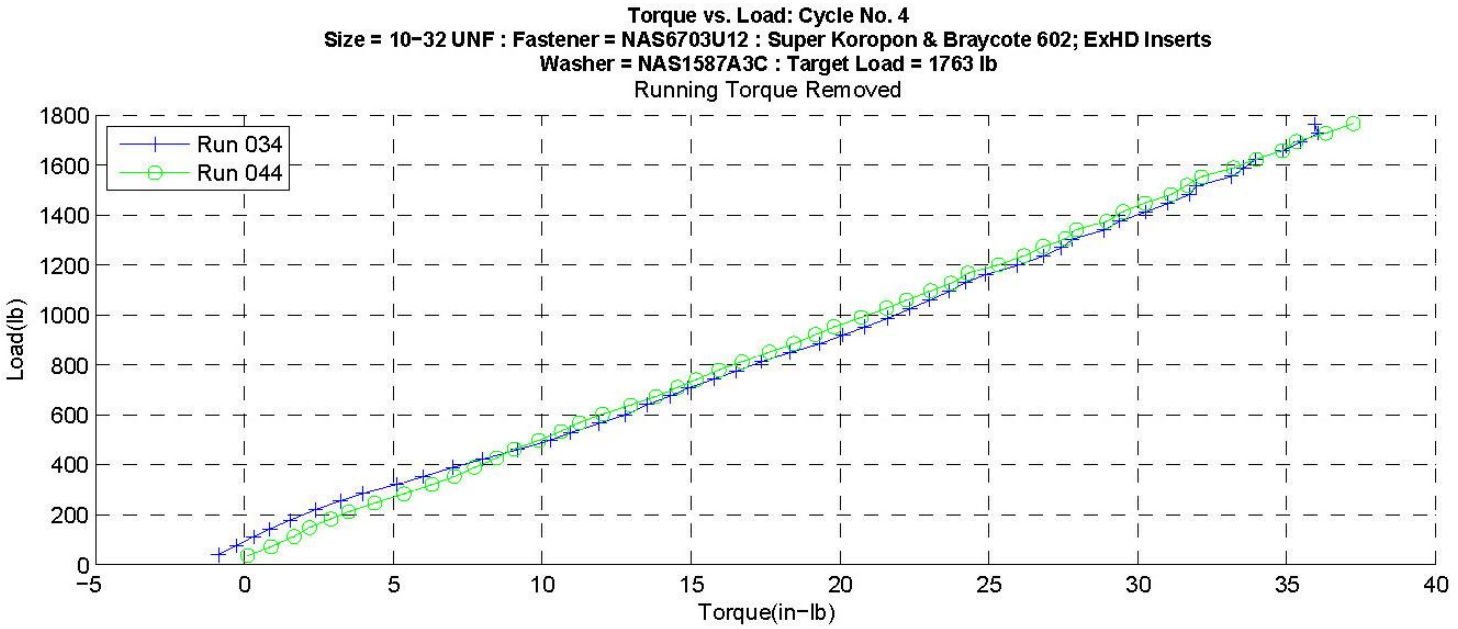

Running Torque Included
Run 031
Run 041
Load(lb)
Torque(in-lb)

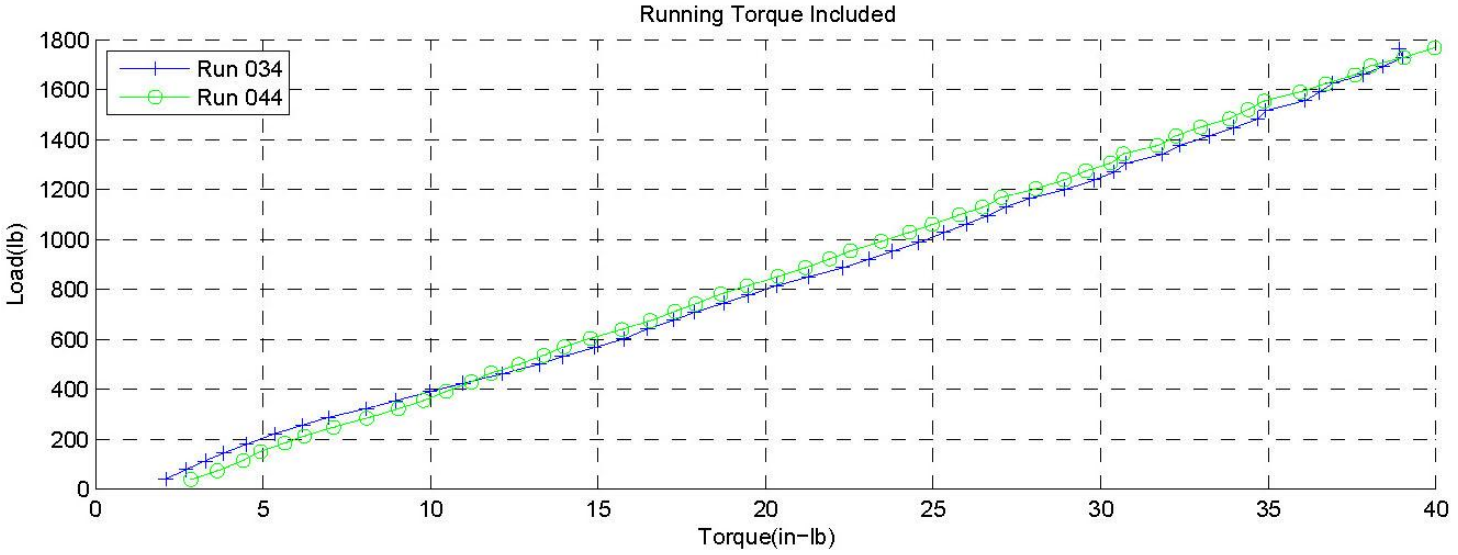

Torque vs. Load: Cycle No. 2
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & Braycote 602; ExHD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 032
Run 042
Load(lb)
Torque(in-lb)

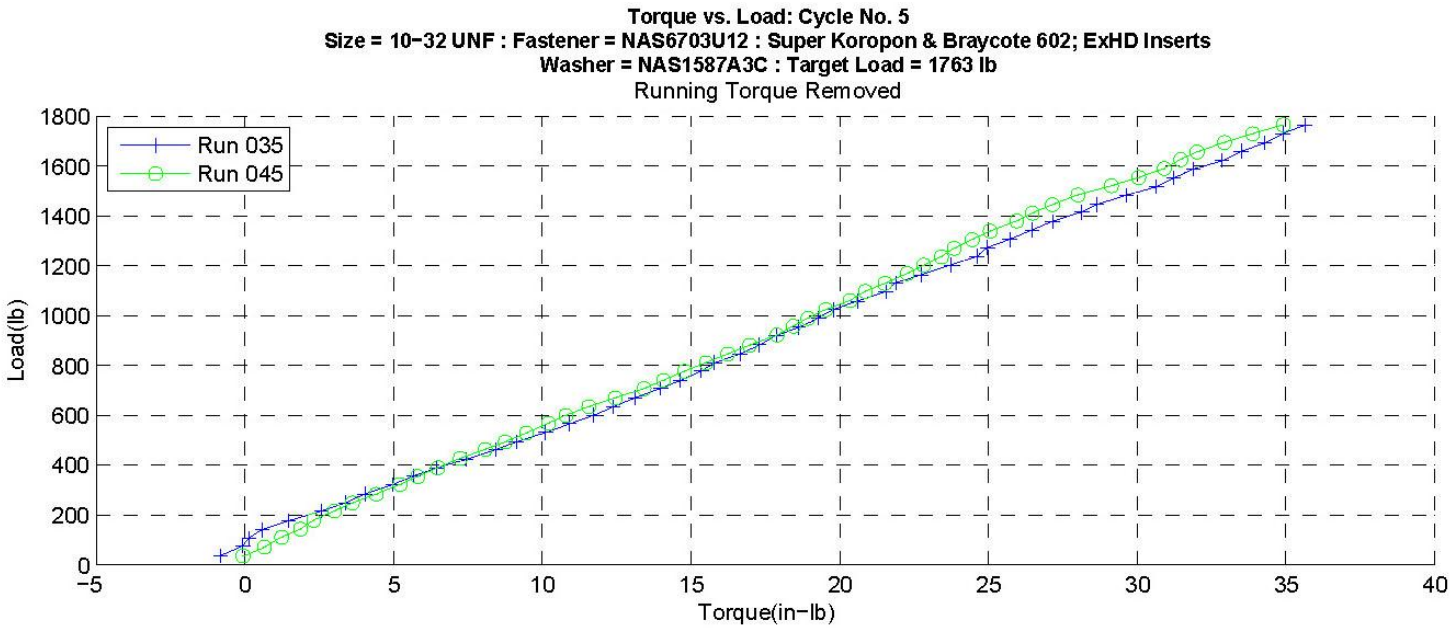

Running Torque Included
Run 032
Run 042
Load(lb)
Torque(in-lb)

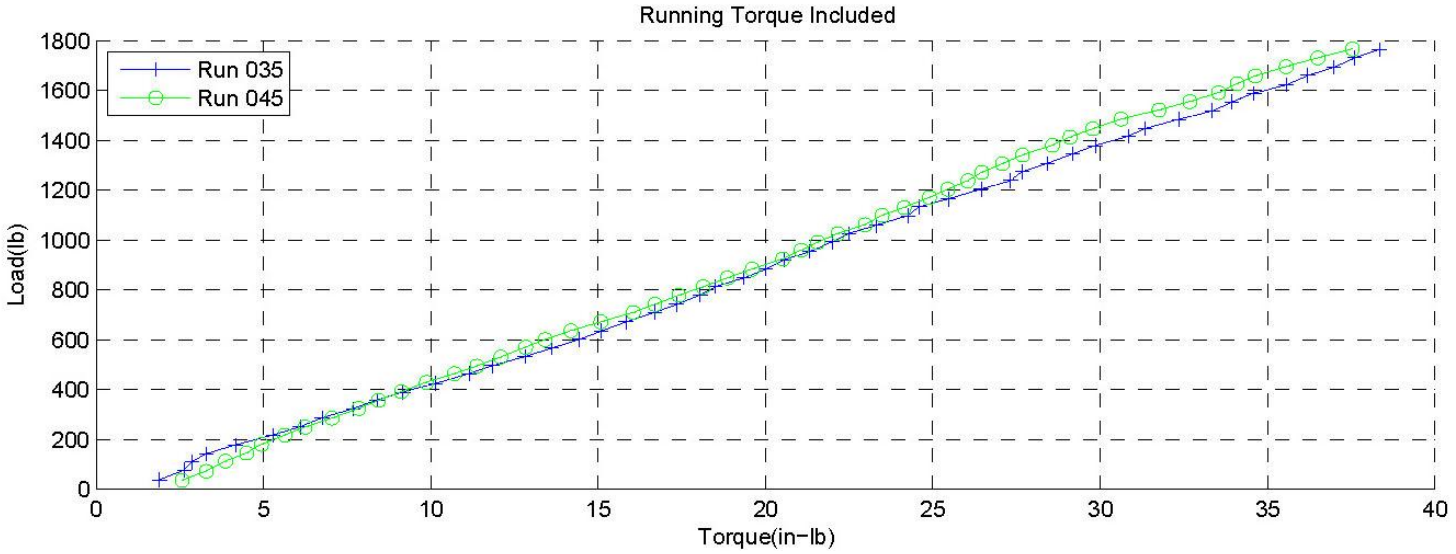

Torque vs. Load: Cycle No. 3
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & Braycote 602; ExHD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 033
Run 043
Load(lb)
Torque(in-lb)

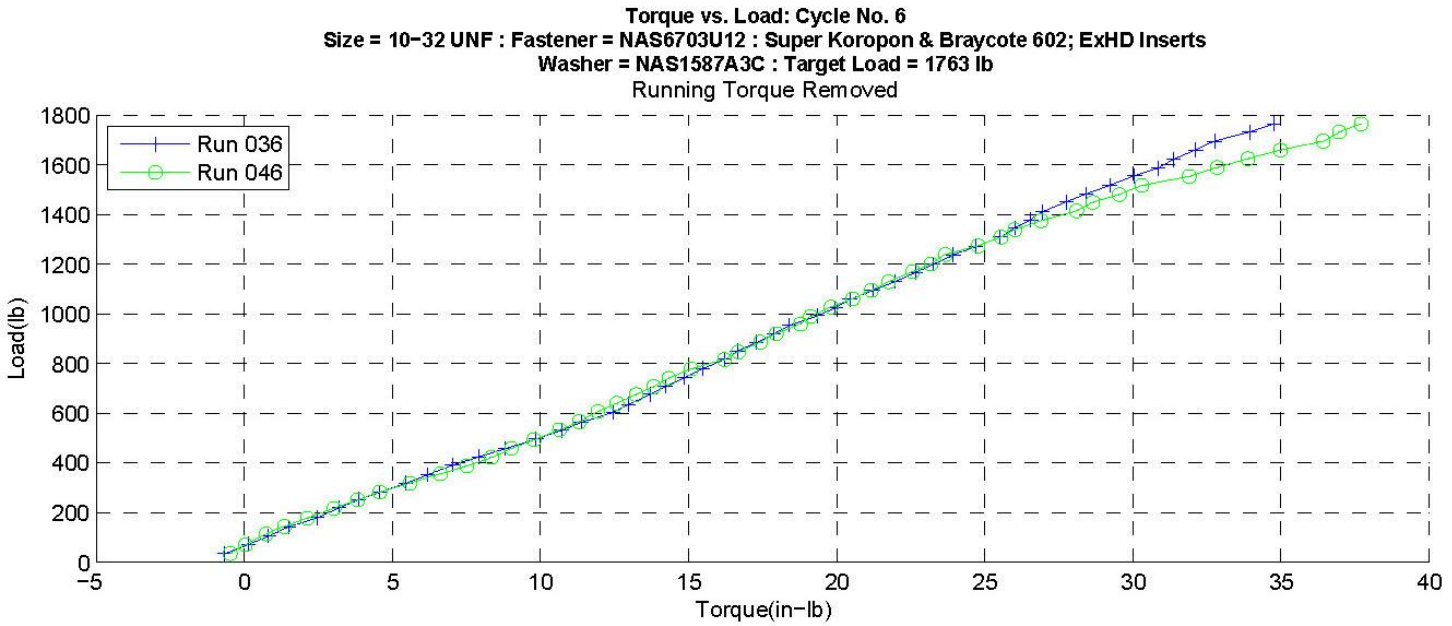

Running Torque Included
Run 033
Run 043
Load(lb)
Torque(in-lb)

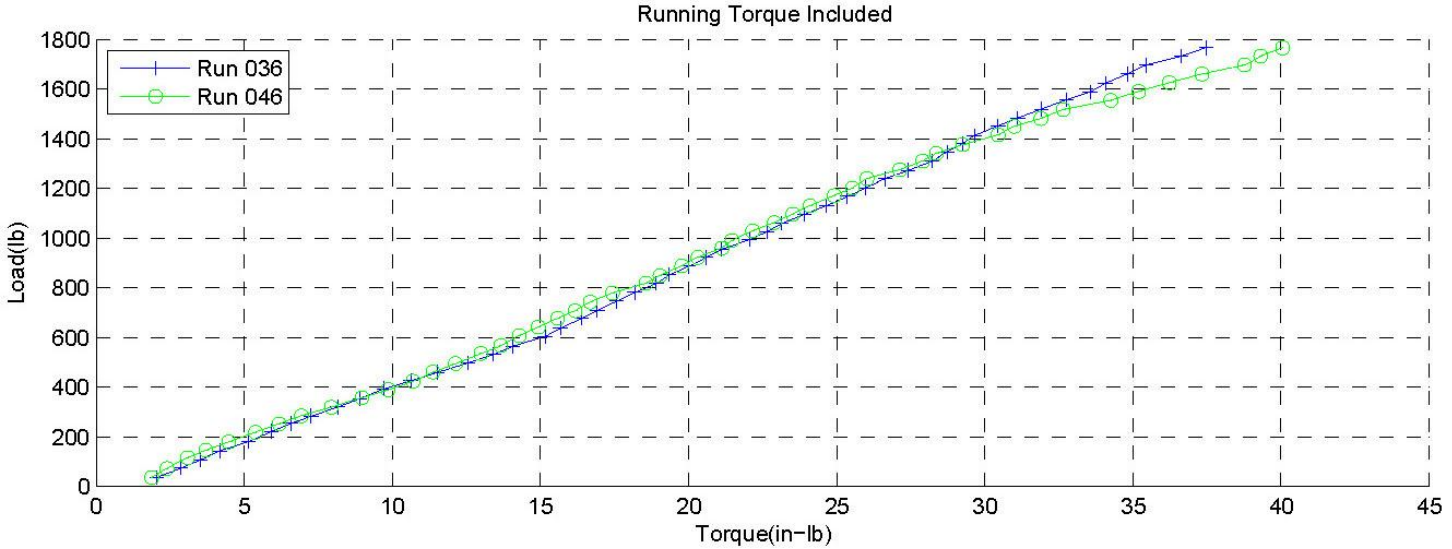

Torque vs. Load: Cycle No. 4
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & Braycote 602; ExHD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 034
Run 044
Load(lb)
Torque(in-lb)
0
200
400
600
800
1000
1200
1400
1600
1800
-5
0
5
10
15
20
25
30
35
40

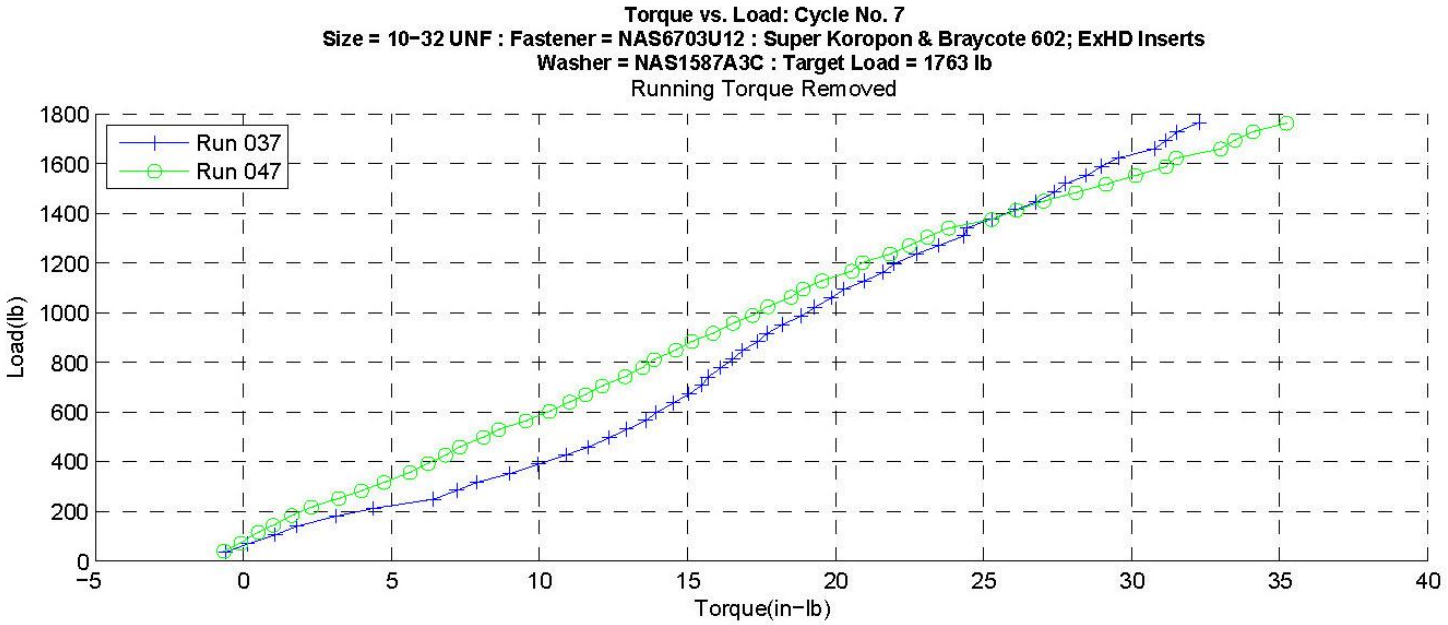

Running Torque Included
Run 034
Run 044
Load(lb)
Torque(in-lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
5
10
15
20
25
30
35
40

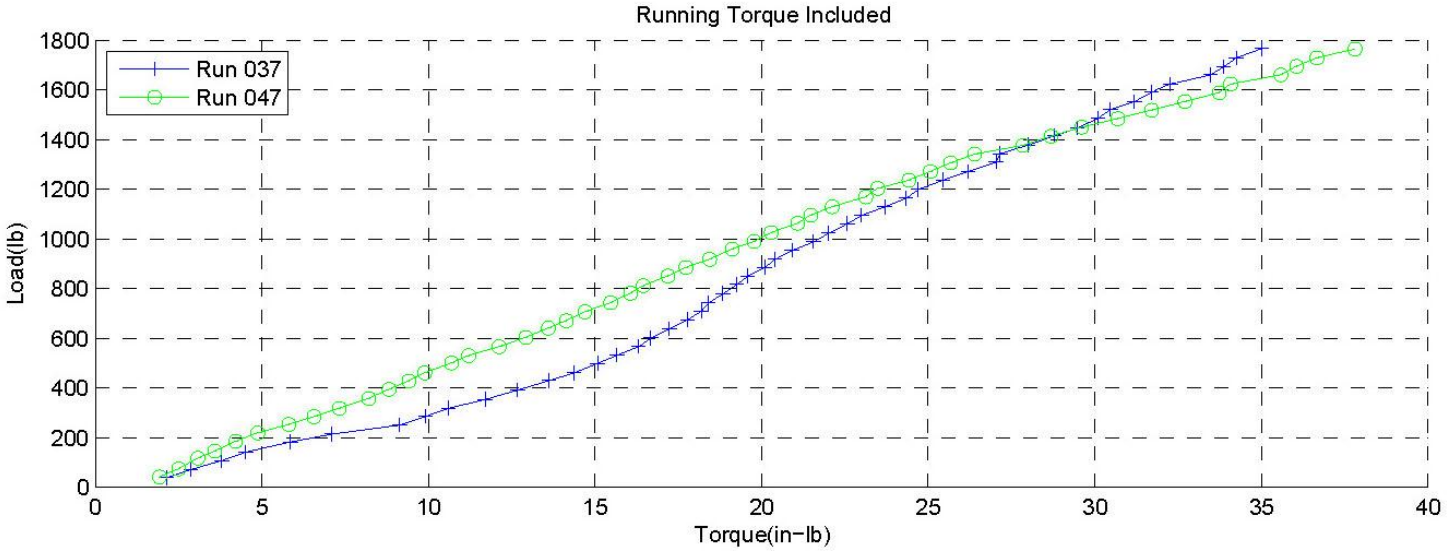

Torque vs. Load: Cycle No. 5
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & Braycote 602; ExHD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 035
Run 045
Load(lb)
Torque(in-lb)
1800
1600
1400
1200
1000
800
600
400
200
0
-5
0
5
10
15
20
25
30
35
40

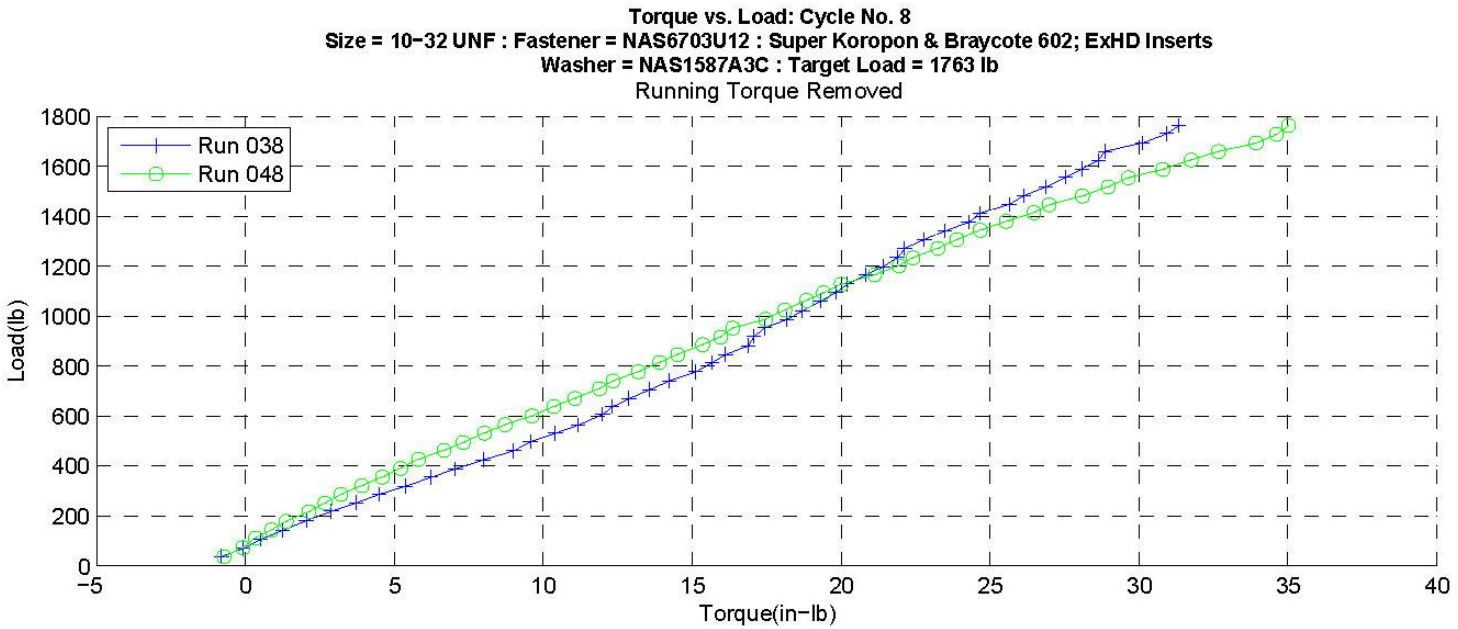

Running Torque Included
Run 035
Run 045
Load(lb)
Torque(in-lb)
1800
1600
1400
1200
1000
800
600
400
200
0
0
5
10
15
20
25
30
35
40

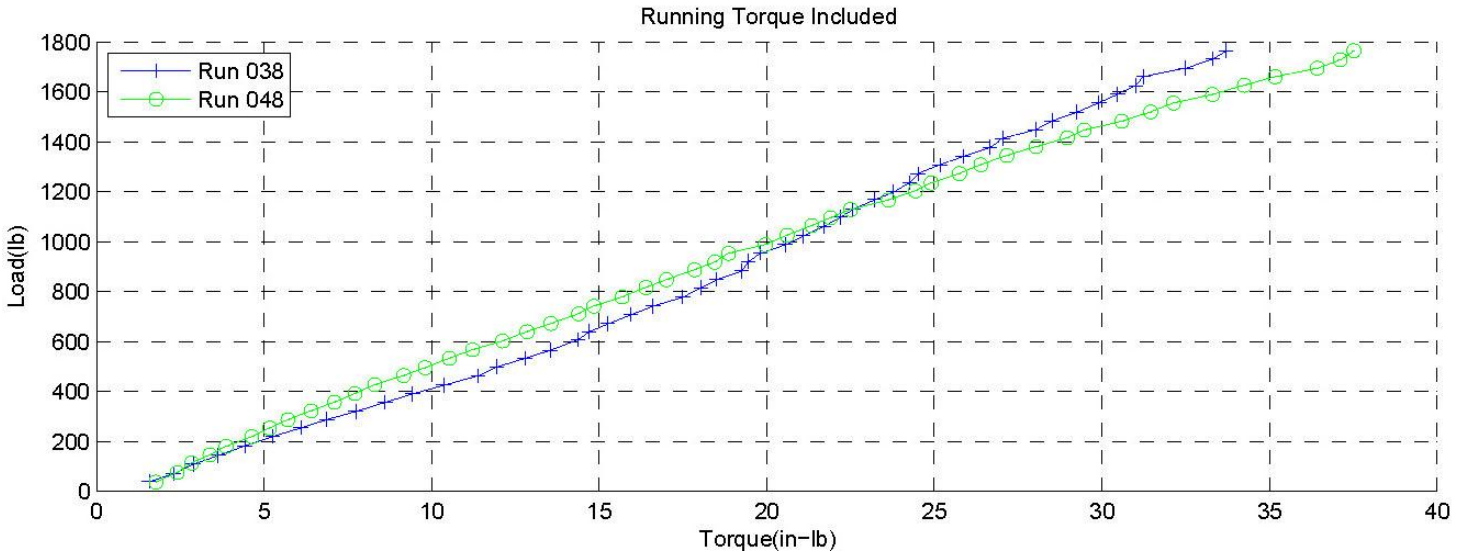

Torque vs. Load: Cycle No. 6
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & Braycote 602; ExHD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 036
Run 046
Load(lb)
Torque(in-lb)
0
200
400
600
800
1000
1200
1400
1600
1800
-5
0
5
10
15
20
25
30
35
40

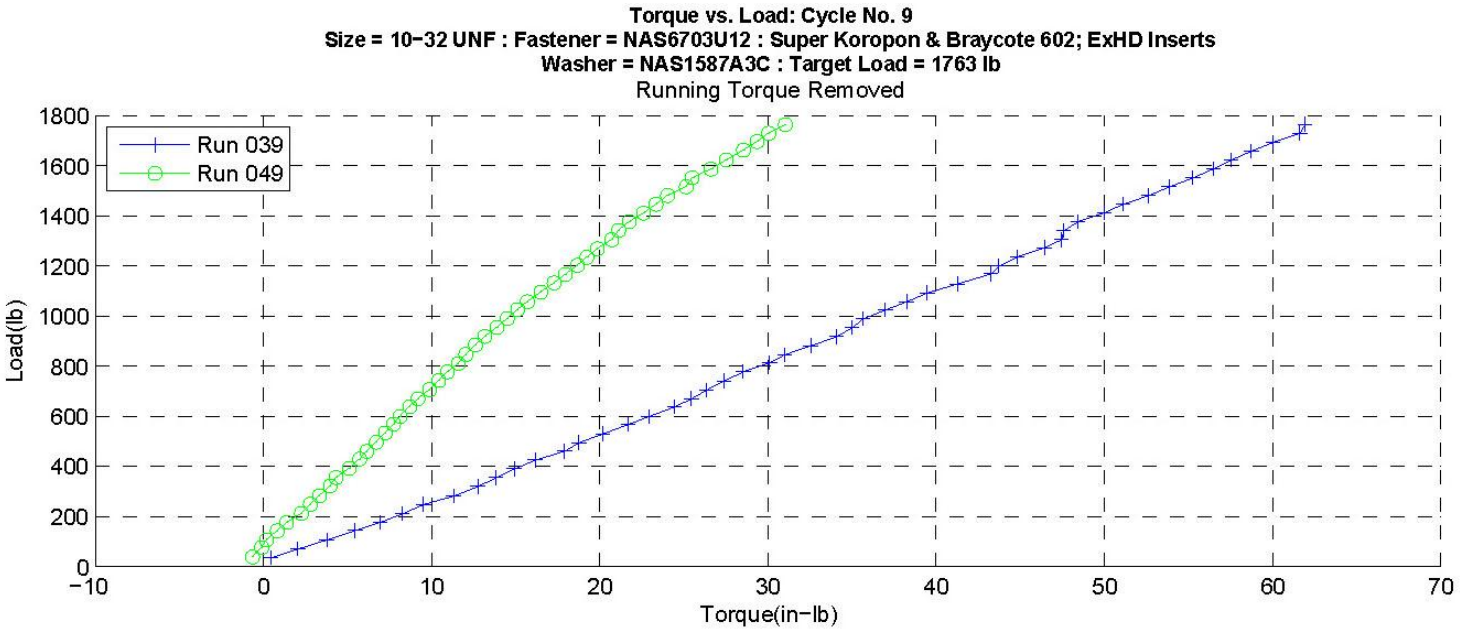

Running Torque Included
Run 036
Run 046
Load(lb)
Torque(in-lb)
0
200
400
600
800
1000
1200
1400
1600
1800
0
5
10
15
20
25
30
35
40
45

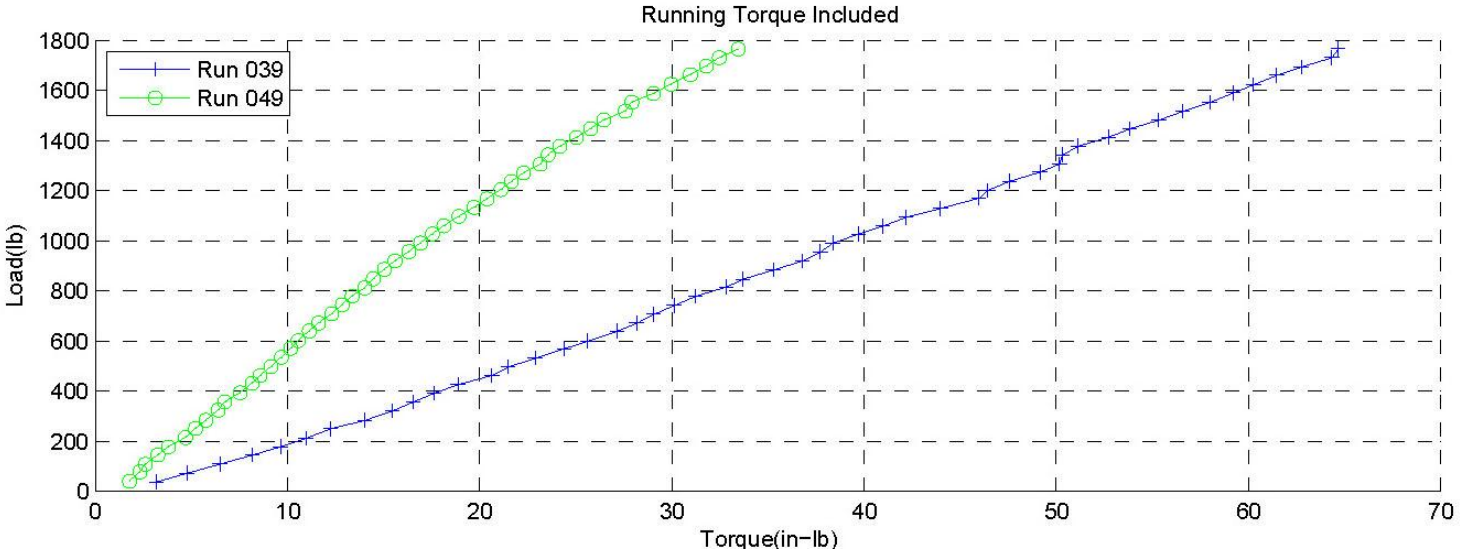

Torque vs. Load: Cycle No. 7
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & Braycote 602; ExHD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 037
Run 047
Load(lb)
Torque(in-lb)

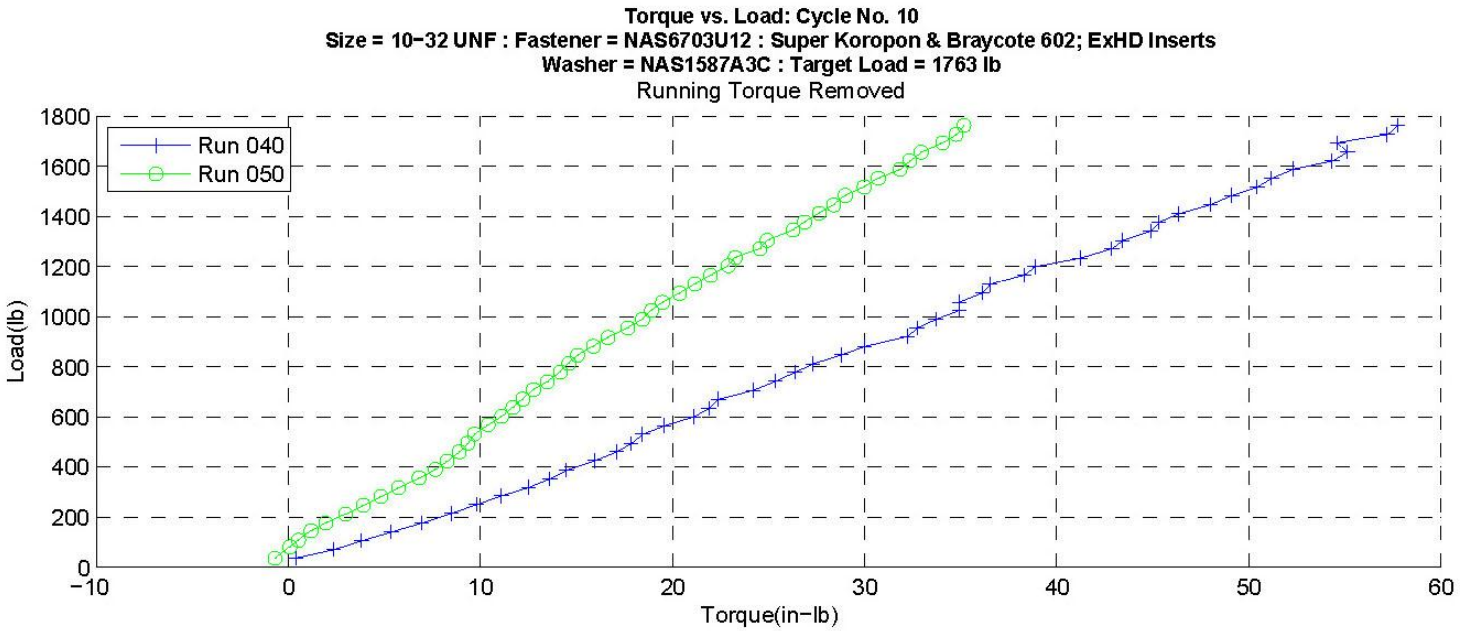

Running Torque Included
Run 037
Run 047
Load(lb)
Torque(in-lb)

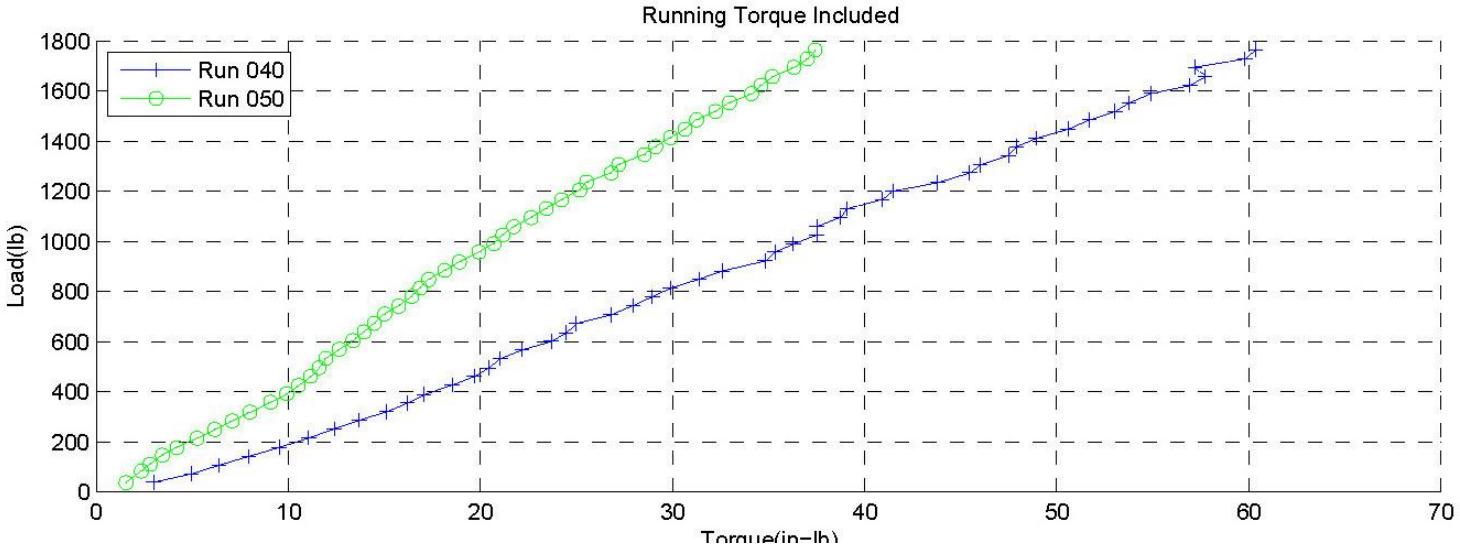

Torque vs. Load: Cycle No. 8
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & Braycote 602; ExHD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 038
Run 048
Load(lb)
Torque(in-lb)


Running Torque Included
Run 038
Run 048
Load(lb)
Torque(in-lb)


Torque vs. Load: Cycle No. 9
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & Braycote 602; ExHD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 039
Run 049
Load(lb)
Torque(in-lb)
1800
1600
1400
1200
1000
800
600
400
200
0
-10
0
10
20
30
40
50
60
70


Running Torque Included
Run 039
Run 049
Load(lb)
Torque(in-lb)
1800
1600
1400
1200
1000
800
600
400
200
0
0
10
20
30
40
50
60
70


Torque vs. Load: Cycle No. 10
Size = 10-32 UNF : Fastener = NAS6703U12 : Super Koropon & Braycote 602; ExHD Inserts
Washer = NAS1587A3C : Target Load = 1763 lb
Running Torque Removed
Run 040
Run 050
Load(lb)
Torque(in-lb)


Running Torque Included
Run 040
Run 050
Load(lb)
Torque(in-lb)

Appendix C:

Section 1	10-32 No Braycote Torque Tension Plots
Section 2	10-32 Braycote 601 Torque Tension Plots
Section 3	10-32 Braycote 602 Torque Tension Plots
Section 4	10-32 No Braycote Running Torque Plots
Section 5	10-32 Braycote 601 Running Torque Plots
Section 6	10-32 Braycote 602 Running Torque Plots
Section 7	10-32 No Braycote Cycle Plots: Torque v. Load
Section 8	10-32 Braycote 601 Cycle Plots: Torque v. Load
Section 9	10-32 Braycote 602 Cycle Plots: Torque v. Load
Section 10	10-32 Friction Coefficients with Statistics
Section 11	10-32 Test Plate Layouts
Section 12	10-32 No Braycote Run Log
Section 13	10-32 Braycote 601 Run Logs
Section 14	10-32 Braycote 602 Run Logs

ORION TEST RESULTS for #10-32 NAS6703U12 FASTENERS (160KSI)

(Super Koropon Lube bolt head and washer, As Received Hardware, no cleaning, running torque removed)

TEST RUN NUMBER	TEST CYCLES INTO LOCKING EXHD KEENSERTS 1	2	3	4	5	6	7	8	9	10	INSERT #	Lube/Insert Type
1	0.116	0.092	0.11	0.102	0.113	0.116	0.123	0.116	0.123	0.124	1	ExHD No Braycote
11	0.115	0.099	0.103	0.1	0.098	0.099	0.097	0.095	0.099	0.092	2	ExHD Braycote 601
21	0.144	0.12	0.123	0.112	0.121	0.117	0.108	0.103	0.100	0.104	3	ExHD Braycote 601
31	0.124	0.111	0.112	0.107	0.106	0.104	0.096	0.093	0.185	0.172	4	ExHD Braycote 602
41	0.115	0.107	0.103	0.111	0.104	0.112	0.105	0.104	0.093	0.105	5	ExHD Braycote 602
51	0.148	0.175	0.156	0.185	0.169	0.158	0.173	0.156	0.156	0.145	6	HD No Braycote
61	0.147	0.147	0.144	0.128	0.134	0.136	0.118	0.118	0.112	0.123	7	HD No Braycote
71	0.132	0.151	0.157	0.163	0.167	0.164	0.17	0.176	0.181	0.175	8	HD No Braycote

0.148	0.175	0.157	0.185	0.169	0.164	0.173	0.176	0.185	0.175		MAX
0.115	0.092	0.103	0.100	0.098	0.099	0.096	0.093	0.093	0.092		MIN
1.041	1.002	1.008	1.008	1.012	1.006	0.990	0.961	1.049	1.040		SUM
0.130	0.125	0.126	0.126	0.127	0.126	0.124	0.120	0.131	0.130		MEAN
0.128	0.116	0.118	0.112	0.117	0.117	0.113	0.110	0.118	0.124		MEDIAN
0.014613	0.029202	0.023003	0.031369	0.027913	0.024371	0.0309	0.030121	0.037597	0.031268		STDVA

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL (one Sided is better fit to data)

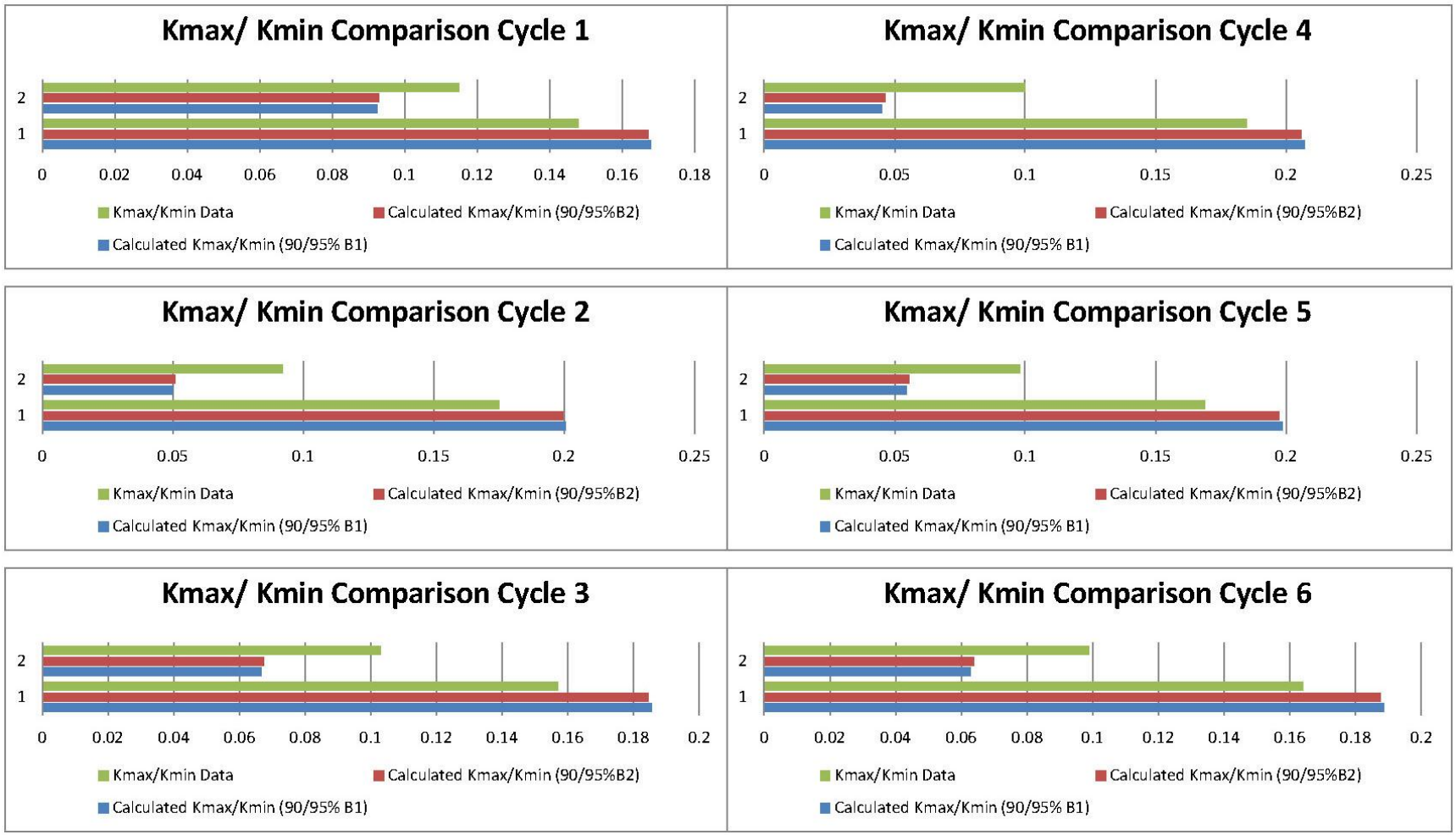
(with 95% conf for 90 & 95% of population)

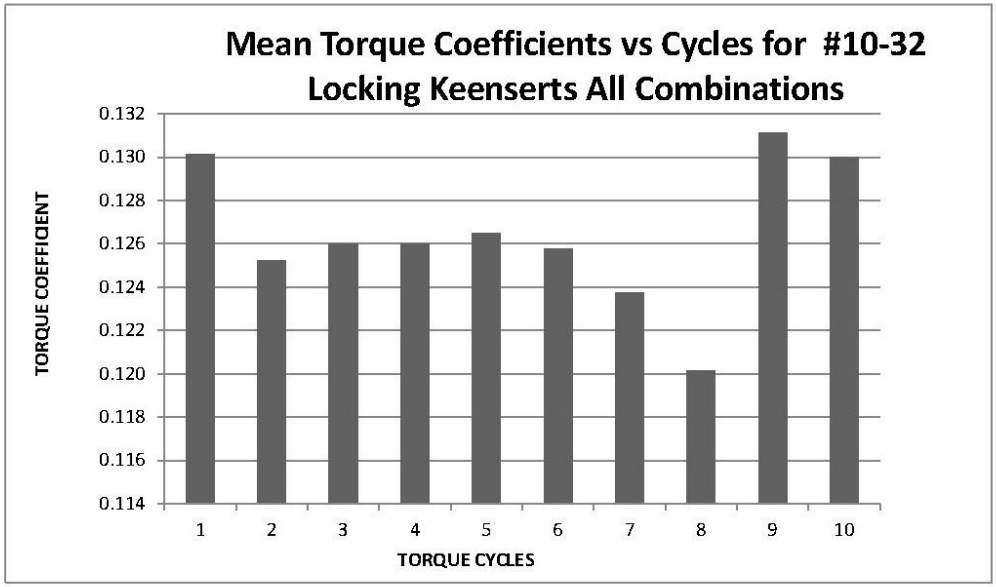
0.167857	0.200651	0.185394	0.206994	0.198572	0.188675	0.203533	0.197897	0.228201	0.210735		Kmax-90%
0.092393	0.049849	0.066606	0.045006	0.054428	0.062825	0.043967	0.042353	0.034049	0.049265		Kmin-90%
0.176698	0.218318	0.199311	0.225972	0.215459	0.203419	0.222227	0.21612	0.250947	0.229652		Kmax-95%
0.083552	0.032182	0.052689	0.026028	0.037541	0.048081	0.025273	0.02413	0.011303	0.030348		Kmin-95%

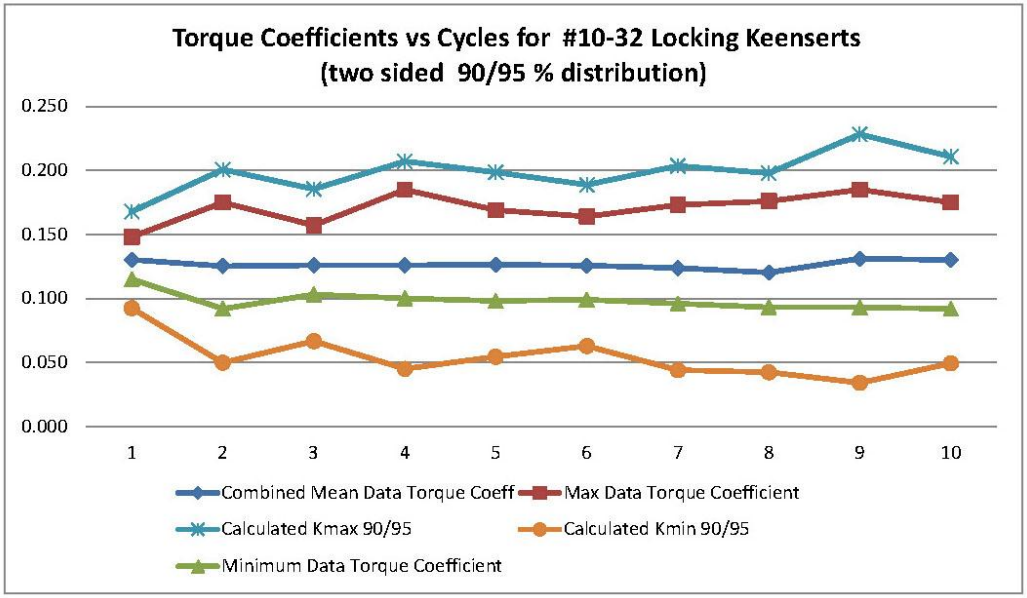
0.289967	0.602003	0.471381	0.642811	0.569737	0.500398	0.644709	0.647427	0.740333	0.621039		VARIANCE 90/95%

B-BASIS TWO SIDED STATISTICAL TOLERANCE INTERVAL

0.167272	0.199483	0.184474	0.205739	0.197455	0.1877	0.202297	0.196692	0.226697	0.209484		Kmax-90%
0.092978	0.051017	0.067526	0.046261	0.055545	0.0638	0.045203	0.043558	0.035553	0.050516		Kmin-90%
0.174316	0.213558	0.195561	0.220859	0.210909	0.199447	0.21719	0.211211	0.244819	0.224556		Kmax-95%
0.085934	0.036942	0.056439	0.031141	0.042091	0.052053	0.03031	0.029039	0.017431	0.035444		Kmin-95%
0.285475	0.592677	0.464079	0.632853	0.56091	0.492646	0.634722	0.637397	0.728863	0.611418		VARIANCE 90/95%


Kmax/ Kmin Comparison Cycle 1
2
1
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
Kmax/Kmin Data
Calculated Kmax/Kmin (90/95%B2)
Calculated Kmax/Kmin (90/95% B1)
Kmax/ Kmin Comparison Cycle 4
2
1
0
0.05
0.1
0.15
0.2
0.25
Kmax/Kmin Data
Calculated Kmax/Kmin (90/95%B2)
Calculated Kmax/Kmin (90/95% B1)
Kmax/ Kmin Comparison Cycle 2
2
1
0
0.05
0.1
0.15
0.2
0.25
Kmax/Kmin Data
Calculated Kmax/Kmin (90/95%B2)
Calculated Kmax/Kmin (90/95% B1)
Kmax/ Kmin Comparison Cycle 5
2
1
0
0.05
0.1
0.15
0.2
0.25
Kmax/Kmin Data
Calculated Kmax/Kmin (90/95%B2)
Calculated Kmax/Kmin (90/95% B1)
Kmax/ Kmin Comparison Cycle 3
2
1
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
Kmax/Kmin Data
Calculated Kmax/Kmin (90/95%B2)
Calculated Kmax/Kmin (90/95% B1)
Kmax/ Kmin Comparison Cycle 6
2
1
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
Kmax/Kmin Data
Calculated Kmax/Kmin (90/95%B2)
Calculated Kmax/Kmin (90/95% B1)


Mean Torque Coefficients vs Cycles for #10-32 Locking Keenserts All Combinations
TORQUE COEFFICIENT
0.132
0.130
0.128
0.126
0.124
0.122
0.120
0.118
0.116
0.114
1
2
3
4
5
6
7
8
9
10
TORQUE CYCLES


Torque Coefficients vs Cycles for #10-32 Locking Keenserts (two sided 90/95 % distribution)
0.250
0.200
0.150
0.100
0.050
0.000
1
2
3
4
5
6
7
8
9
10
Combined Mean Data Torque Coeff
Max Data Torque Coefficient
Calculated Kmax 90/95
Calculated Kmin 90/95
Minimum Data Torque Coefficient

ORION TEST RESULTS for #10-32 NAS6703U12 FASTENERS (160KSI)

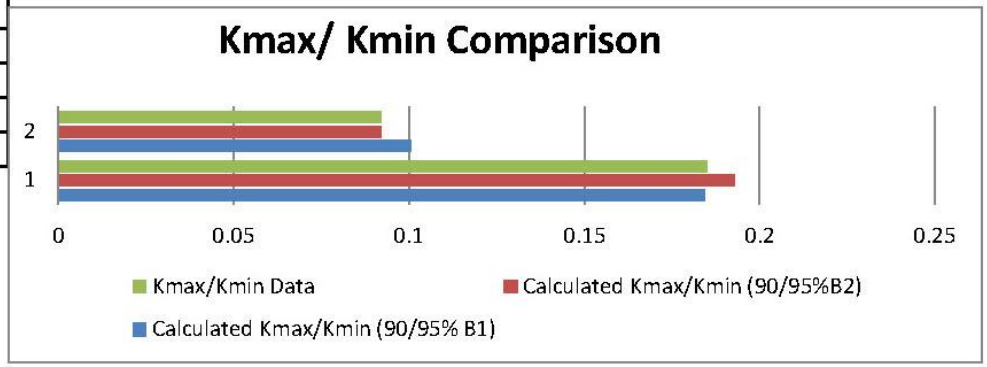
(Super Koropon Lube bolt head and washer, As Received Hardware, no cleaning, running torque removed)

TEST RUN NUMBER	TEST CYCLES INTO LOCKING EXHD KEENSERTS 1	2	3	4	5	6	7	8	9	10	INSERT #	Lube/Insert Type
1	0.116	0.092	0.11	0.102	0.113	0.116	0.123	0.116	0.123	0.124	1	ExHD No Braycote
51	0.148	0.175	0.156	0.185	0.169	0.158	0.173	0.156	0.156	0.145	6	HD No Braycote
61	0.147	0.147	0.144	0.128	0.134	0.136	0.118	0.118	0.112	0.123	7	HD No Braycote
71	0.132	0.151	0.157	0.163	0.167	0.164	0.17	0.176	0.181	0.175	8	HD No Braycote

5.699		SUM ExHD	
0.142		AVE ExHD	
0.146		MED ExHD	
0.024712		STDVA ExHD	
0.184411		Kmax 90/95 B1	
0.100539		Kmin 90/95 B1	
0.185		Max Test	
0.092		Min Test	
0.193257		Kmax 90/95 B2	
0.091693		Kmin 90/95 B2	

Friction Factors for ExHD & HD Keenserts, no Braycote

	Calculated B-basis 90/95% Probability (n=40)			Test Based
	B-basis one sided		B-Basis two sided	Measured values
Kmax	0.1844		0.193	0.185
Kmin	0.1005		0.092	0.092



ORION TEST RESULTS for #10-32 NAS6703U12 FASTENERS (160KSI)

(Super Koropon Lube bolt head and washer, As Received Hardware, no cleaning, running torque removed)

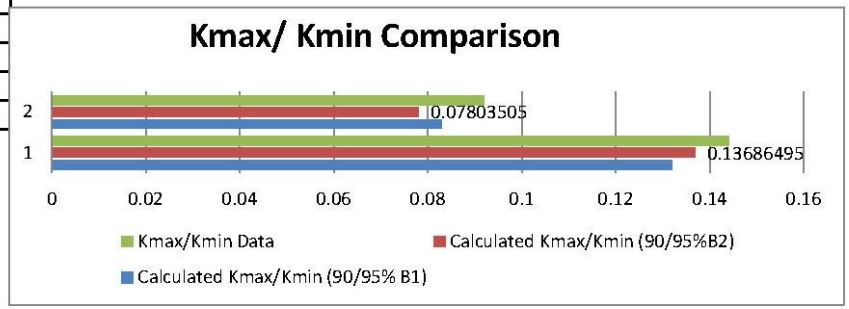
TEST RUN NUMBER	TEST CYCLES INTO LOCKING EXHD KEENSERTS 1	2	3	4	5	6	7	8	9	10	INSERT #	Lube/Insert Type
11	0.115	0.099	0.103	0.1	0.098	0.099	0.097	0.095	0.099	0.092	2	ExHD Braycote 601
21	0.144	0.12	0.123	0.112	0.121	0.117	0.108	0.103	0.100	0.104	3	ExHD Braycote 601
31	0.124	0.111	0.112	0.107	0.106	0.104	0.096	0.093	0.185	0.172	4	ExHD Braycote 602
41	0.115	0.107	0.103	0.111	0.104	0.112	0.105	0.104	0.093	0.105	5	ExHD Braycote 602

2.149		SUM ExHD	
0.107		AVE ExHD	
0.103		MED ExHD	
0.012684		STDVA ExHD	
0.13188		Kmax 90/95 B1	
0.08302		Kmin 90/95 B1	
0.144		Max Test	
0.092		Min Test	
0.136865		Kmax 90/95 B2	
0.078035		Kmin 90/95 B2	

Friction Factors for ExHD & HD Keenserts, Braycote 601

Calculated values based on 90/95% Probability — Test Based

	B-basis one sided		B-Basis two sided	Measured values
Kmax	0.132		0.137	0.144
Kmin	0.083		0.078	0.092

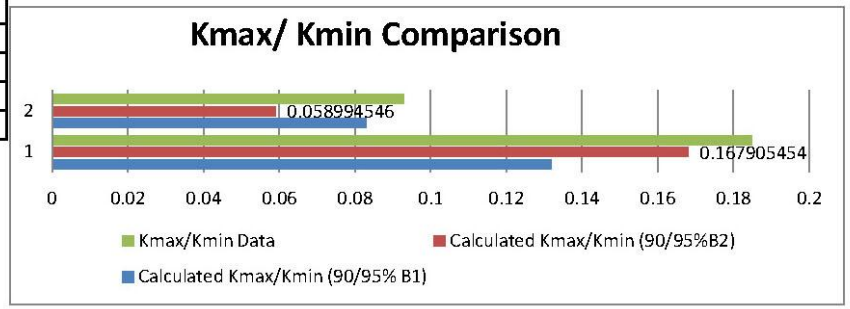


2.269		SUM ExHD	
0.113		AVE ExHD	
0.107		MED ExHD	
0.023482		STDVA ExHD	
0.158677		Kmax 90/95 B1	
0.068223		Kmin 90/95 B1	
0.185		Max Test	
0.093		Min Test	
0.167905		Kmax 90/95 B2	
0.058995		Kmin 90/95 B2	

Friction Factors for ExHD & HD Keenserts, Braycote 602

Calculated values based on 90/95% Probability — Test Based

	B-basis one sided		B-Basis two sided	Measured values
Kmax	0.159		0.168	0.185
Kmin	0.068		0.059	0.093



ORION TEST RESULTS for #10-32 NAS6703U12 FASTENERS (160KSI)

(Super Koropon Lube bolt head and washer, As Received Hardware, no cleaning, running torque removed)

TEST RUN NUMBER	TEST CYCLES INTO LOCKING EXHD KEENSERTS 1	2	3	4	5	6	7	8	9	10	INSERT #	Lube/Insert Type
1	0.116	0.092	0.11	0.102	0.113	0.116	0.123	0.116	0.123	0.124	1	ExHD No Braycote
11	0.115	0.099	0.103	0.1	0.098	0.099	0.097	0.095	0.099	0.092	2	ExHD Braycote 601
21	0.144	0.12	0.123	0.112	0.121	0.117	0.108	0.103	0.100	0.104	3	ExHD Braycote 601
31	0.124	0.111	0.112	0.107	0.106	0.104	0.096	0.093	0.185	0.172	4	ExHD Braycote 602
41	0.115	0.107	0.103	0.111	0.104	0.112	0.105	0.104	0.093	0.105	5	ExHD Braycote 602
51	0.148	0.175	0.156	0.185	0.169	0.158	0.173	0.156	0.156	0.145	6	HD No Braycote
61	0.147	0.147	0.144	0.128	0.134	0.136	0.118	0.118	0.112	0.123	7	HD No Braycote
71	0.132	0.151	0.157	0.163	0.167	0.164	0.17	0.176	0.181	0.175	8	HD No Braycote

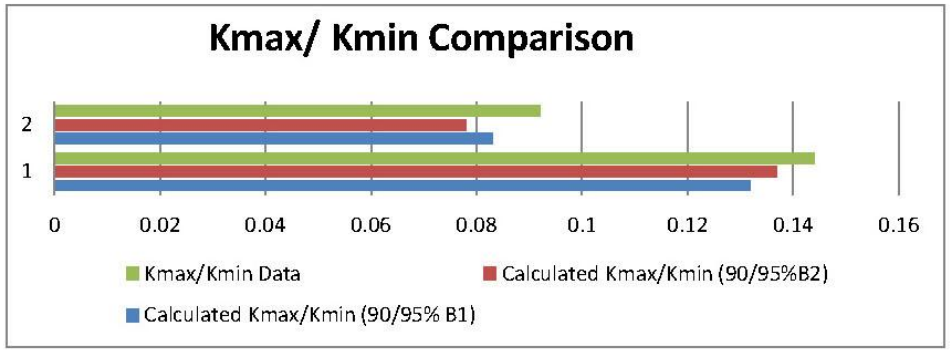
10.117		SUM ExHD	
0.126		AVE ExHD	
0.117		MED ExHD	
0.027147485		STDVA ExHD	
0.167726677		Kmax 90/95 B1	
0.085198323		Kmin 90/95 B1	
0.185		Max Test	
0.092		Min Test	
0.17967157		Kmax 90/95 B2	
0.07325343		Kmin 90/95 B2	

Friction Factors for ExHD & HD Keenserts, All Combinations

	Calculated values based on 90/95% Probability		Test Based
	B-basis one sided	B-Basis two sided	Measured values
Kmax	0.168	0.18	0.185
Kmin	0.085	0.073	0.092

Note: B basis calculations based on sample n=80.

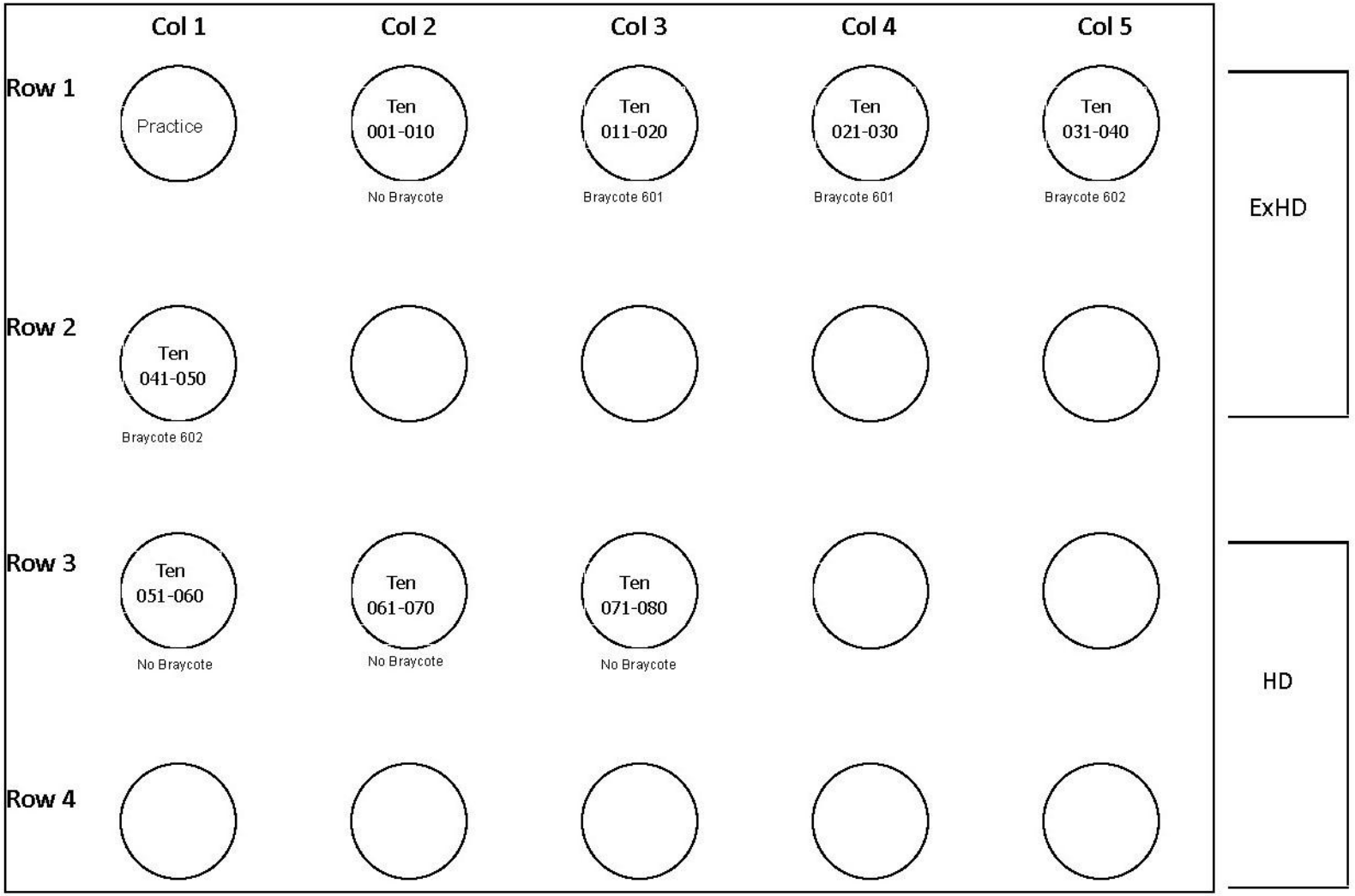
Conclusion- Calculated B-basis values of Kmax & Kmin are not be conservative.
ie. Kmax calculated is less than measured & Kmin calculated is greater than measured value.



Appendix C:

Section 1	10-32 No Braycote Torque Tension Plots
Section 2	10-32 Braycote 601 Torque Tension Plots
Section 3	10-32 Braycote 602 Torque Tension Plots
Section 4	10-32 No Braycote Running Torque Plots
Section 5	10-32 Braycote 601 Running Torque Plots
Section 6	10-32 Braycote 602 Running Torque Plots
Section 7	10-32 No Braycote Cycle Plots: Torque v. Load
Section 8	10-32 Braycote 601 Cycle Plots: Torque v. Load
Section 9	10-32 Braycote 602 Cycle Plots: Torque v. Load
Section 10	10-32 Friction Coefficients with Statistics
Section 11	10-32 Test Plate Layouts
Section 12	10-32 No Braycote Run Log
Section 13	10-32 Braycote 601 Run Logs
Section 14	10-32 Braycote 602 Run Logs

#10-32 Fastener Plate Layout (Not to Scale)



ExHD = Extra Heavy Duty Inserts (Row 1&2) : MS51832CA202L : Lot No. 232019; [Batch No. 404556]

HD = Heavy Duty Inserts (Row 3&4) : MS51831CA202L : Lot No. 230976; [Batch No. 412206]

Appendix C:

Section 1	10-32 No Braycote Torque Tension Plots
Section 2	10-32 Braycote 601 Torque Tension Plots
Section 3	10-32 Braycote 602 Torque Tension Plots
Section 4	10-32 No Braycote Running Torque Plots
Section 5	10-32 Braycote 601 Running Torque Plots
Section 6	10-32 Braycote 602 Running Torque Plots
Section 7	10-32 No Braycote Cycle Plots: Torque v. Load
Section 8	10-32 Braycote 601 Cycle Plots: Torque v. Load
Section 9	10-32 Braycote 602 Cycle Plots: Torque v. Load
Section 10	10-32 Friction Coefficients with Statistics
Section 11	10-32 Test Plate Layouts
Section 12	10-32 No Braycote Run Log
Section 13	10-32 Braycote 601 Run Logs
Section 14	10-32 Braycote 602 Run Logs

Orion NESC Torque Tension Run Log

Date: 7/29/2011
Time: 3:00pM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.1,19.9,50.8
Temperature(°F): Start/End of D 68.1/68.9
Humidity(%): Start/End of D 63/60

Tor Wrench Op: Mcleod
Data Sys. Op: Peil
Notes: FilenamePrefix: Ten 001-010 (TNB 001-010)
Fastener Spec: NAS6703U12
Washer Spec:
The torque wrench has a in-lb capacity
calibrated out to 300 in-lb
Torque Wrench: S/N:

Cord	Cycle No.	Fastener Size	Target Load (lb)	Brk Torq (In-lb)	Lubrication Type			Comments	Breakaway Running Torq (In-lb)
					None	Braycote 601	Braycote 602		
1,2	1	#10-32	1598	35	X			using 10-32J designation in labview	9
1,2	2	#10-32	1598	25	X			using 10-32 designation in labview	9
1,2	3	#10-32	1598	38	X				7
1,2	4	#10-32	1598	27.2	X				6.6
1,2	5	#10-32	1598	28.5	X				5.5
1,2	6	#10-32	1598	28	X				5.5
1,2	7	#10-32	1598	29.8	X				5
1,2	8	#10-32	1598	28.5	X				5
1,2	9	#10-32	1598	29	X				5
1,2	10	#10-32	1598	31.8	X				5

Orion NESC Torque Tension Run Log

Date: 8/1/2011
Time: 3:55PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.0,20.1,50.3
Temperature(°F): Start/End of D 68.1/68.3
Humidity(%): Start/End of D 58/58

Tor Wrench Op: Mcleod
Data Sys. Op: Peil
Notes: FilenamePrefix: Ten 051-060 (TNB 011-020)
Fastener Spec: NAS6703U12
Washer Spec:
The torque wrench has a in-lb capacity
calibrated out to 300 in-lb
Torque Wrench: S/N:

Cord	Cycle No.	Fastener Size	Target Load (lb)	Brk Torq (In-lb)	Lubrication Type			Comments	Breakaway Running Torq (In-lb)
					None	Braycote 601	Braycote 602		
3,1	1	#10-32	1763	44	X				6.5
3,1	2	#10-32	1763	47.5	X				7.5
3,1	3	#10-32	1763	42.5	X				7
3,1	4	#10-32	1763	54	X				8
3,1	5	#10-32	1763	47	X				7
3,1	6	#10-32	1763	44	X				7
3,1	7	#10-32	1763	47	X				6.5
3,1	8	#10-32	1763	42	X				6
3,1	9	#10-32	1763	40	X				6
3,1	10	#10-32	1763	37.5	X				6.5

Orion NESC Torque Tension Run Log

Date: 8/2/2011
Time: 10:35AM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.0,19.9,49.9
Temperature(°F): Start/End of D 65.8/66.2
Humidity(%): Start/End of D 63/61

Tor Wrench Op: Mcleod
Data Sys. Op: Peil
Notes: FilenamePrefix: Ten 061-070 (TNB 021-030)
Fastener Spec: NAS6703U12
Washer Spec: NAS1587A3C
The torque wrench has a in-lb capacity
calibrated out to 300 in-lb
Torque Wrench: S/N:

Cord	Cycle No.	Fastener Size	Target Load (lb)	Brk Torq (In-lb)	Lubrication Type			Comments	Breakaway Running Torq (In-lb)
					None	Braycote 601	Braycote 602		
3,2	1	#10-32	1763	45	X			using 10-32J designation in labview, noticeable slip while torqueing	4.1
3,2	2	#10-32	1763	36	X				5
3,2	3	#10-32	1763	37	X				5.5
3,2	4	#10-32	1763	33	X				5.1
3,2	5	#10-32	1763	33	X				5
3,2	6	#10-32	1763	38	X				5
3,2	7	#10-32	1763	25	X				5
3,2	8	#10-32	1763	25	X				4.9
3,2	9	#10-32	1763	25	X				4.5
3,2	10	#10-32	1763	29	X				4.5

Orion NESC Torque Tension Run Log

Date: 8/2/2011
Time: 11:14AM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.0,19.9,49.9
Temperature(°F): Start/End of D 66.2/66.3
Humidity(%): Start/End of D 61/59

Tor Wrench Op: Mcleod
Data Sys. Op: Peil
Notes: FilenamePrefix: Ten 071-080 (TNB 031-040)
Fastener Spec: NAS6703U12
Washer Spec: NAS1587A3C
The torque wrench has a in-lb capacity
calibrated out to 300 in-lb
Torque Wrench: S/N:

Cord	Cycle No.	Fastener Size	Target Load (lb)	Brk Torq (In-lb)	Lubrication Type			Comments	Breakaway Running Torq (In-lb)
					None	Braycote 601	Braycote 602		
3,3	1	#10-32	1763	42.5	X			using 10-32J designation in labview	8
3,3	2	#10-32	1763	45	X				7.6
3,3	3	#10-32	1763	45	X				7
3,3	4	#10-32	1763	47	X				7.5
3,3	5	#10-32	1763	47.5	X				7.5
3,3	6	#10-32	1763	46	X				7.5
3,3	7	#10-32	1763	47.5	X				7.5
3,3	8	#10-32	1763	51	X				7
3,3	9	#10-32	1763	50	X				6.2
3,3	10	#10-32	1763	47.5	X			definite galling on threads noticed during bolt cleaning	6

Appendix C:

Section 1	10-32 No Braycote Torque Tension Plots
Section 2	10-32 Braycote 601 Torque Tension Plots
Section 3	10-32 Braycote 602 Torque Tension Plots
Section 4	10-32 No Braycote Running Torque Plots
Section 5	10-32 Braycote 601 Running Torque Plots
Section 6	10-32 Braycote 602 Running Torque Plots
Section 7	10-32 No Braycote Cycle Plots: Torque v. Load
Section 8	10-32 Braycote 601 Cycle Plots: Torque v. Load
Section 9	10-32 Braycote 602 Cycle Plots: Torque v. Load
Section 10	10-32 Friction Coefficients with Statistics
Section 11	10-32 Test Plate Layouts
Section 12	10-32 No Braycote Run Log
Section 13	10-32 Braycote 601 Run Logs
Section 14	10-32 Braycote 602 Run Logs

Orion NESC Torque Tension Run Log

Date: 7/29/2011
Time: 4:10PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.1,19.9,50.8
Temperature(°F): Start/End of D 68.9/69
Humidity(%): Start/End of D 60/60

Tor Wrench Op: Mcleod
Data Sys. Op: Peil
Notes: FilenamePrefix: Ten 011-020 (T601B 001-010)
Fastener Spec: NAS6703U12
Washer Spec:
The torque wrench has a in-lb capacity
calibrated out to 300 in-lb
Torque Wrench: S/N:

Cord	Cycle No.	Fastener Size	Target Load (lb)	Brk Torq (In-lb)	Lubrication Type			Comments	Breakaway Running Torq (In-lb)
					None	Braycote 601	Braycote 602		
1,3	1	#10-32	1598	26		X		using 10-32 designation in labview	5.5
1,3	2	#10-32	1598	23		X			4
1,3	3	#10-32	1598	24.5		X			3
1,3	4	#10-32	1598	23.2		X			2.8
1,3	5	#10-32	1598	21		X			2.1
1,3	6	#10-32	1598	23		X			2.5
1,3	7	#10-32	1598	23		X			2.5
1,3	8	#10-32	1598	20.5		X			2.4
1,3	9	#10-32	1598	20		X			2
1,3	10	#10-32	1598	18		X			2

Orion NESC Torque Tension Run Log

Date: 8/1/2011
Time: 1:35PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.0,20.1,50.3
Temperature(°F): Start/End of D 67.1/67.8
Humidity(%): Start/End of D 59/58

Tor Wrench Op: Mcleod
Data Sys. Op: Peil
Notes: FilenamePrefix: Ten 021-030 (T601B 011-020)
Fastener Spec: NAS6703U12
Washer Spec:
The torque wrench has a in-lb capacity
calibrated out to 300 in-lb
Torque Wrench: S/N:

Cord	Cycle No.	Fastener Size	Target Load (lb)	Brk Torq (In-lb)	Lubrication Type			Comments	Breakaway Running Torq (In-lb)
					None	Braycote 601	Braycote 602		
1,4	1	#10-32	1763	39		X		using 10-32J designation in labview, noticeable slip while torqueing	7
1,4	2	#10-32	1763	27.5		X			6
1,4	3	#10-32	1763	30		X			5.5
1,4	4	#10-32	1763	25		X			4.5
1,4	5	#10-32	1763	27		X			4
1,4	6	#10-32	1763	26		X			3.5
1,4	7	#10-32	1763	28		X			3.4
1,4	8	#10-32	1763	22.5		X			3
1,4	9	#10-32	1763	20.5		X			3
1,4	10	#10-32	1763	20		X			3

Appendix C:

Section 1	10-32 No Braycote Torque Tension Plots
Section 2	10-32 Braycote 601 Torque Tension Plots
Section 3	10-32 Braycote 602 Torque Tension Plots
Section 4	10-32 No Braycote Running Torque Plots
Section 5	10-32 Braycote 601 Running Torque Plots
Section 6	10-32 Braycote 602 Running Torque Plots
Section 7	10-32 No Braycote Cycle Plots: Torque v. Load
Section 8	10-32 Braycote 601 Cycle Plots: Torque v. Load
Section 9	10-32 Braycote 602 Cycle Plots: Torque v. Load
Section 10	10-32 Friction Coefficients with Statistics
Section 11	10-32 Test Plate Layouts
Section 12	10-32 No Braycote Run Log
Section 13	10-32 Braycote 601 Run Logs
Section 14	10-32 Braycote 602 Run Logs

Orion NESC Torque Tension Run Log

Date: 8/1/2011
Time: 2:33PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.0,20.1,50.3
Temperature(°F): Start/End of D 67.8/68.1
Humidity(%): Start/End of D 58/58

Tor Wrench Op: Mcleod
Data Sys. Op: Peil
Notes: FilenamePrefix: Ten 031-040 (T602B 001-010)
Fastener Spec: NAS6703U12
Washer Spec:
The torque wrench has a in-lb capacity
calibrated out to 300 in-lb
Torque Wrench: S/N:

Cord	Cycle No.	Fastener Size	Target Load (lb)	Brk Torq (In-lb)	Lubrication Type			Comments	Breakaway Running Torq (In-lb)
					None	Braycote 601	Braycote 602		
1,5	1	#10-32	1763	27.5			X		4
1,5	2	#10-32	1763	29			X		4
1,5	3	#10-32	1763	26			X		3.3
1,5	4	#10-32	1763	26			X		3.5
1,5	5	#10-32	1763	25.5			X		2.5
1,5	6	#10-32	1763	23			X		2.5
1,5	7	#10-32	1763	20.8			X		2.5
1,5	8	#10-32	1763	17.5			X		2.2
1,5	9	#10-32	1763	47.5			X	no obvious reason for jump in break torque	2
1,5	10	#10-32	1763	43			X		2.5

Orion NESC Torque Tension Run Log

Date: 8/1/2011
Time: 3:15PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.0,20.1,50.3
Temperature(°F): Start/End of D 68.1/68.1
Humidity(%): Start/End of D 58/58

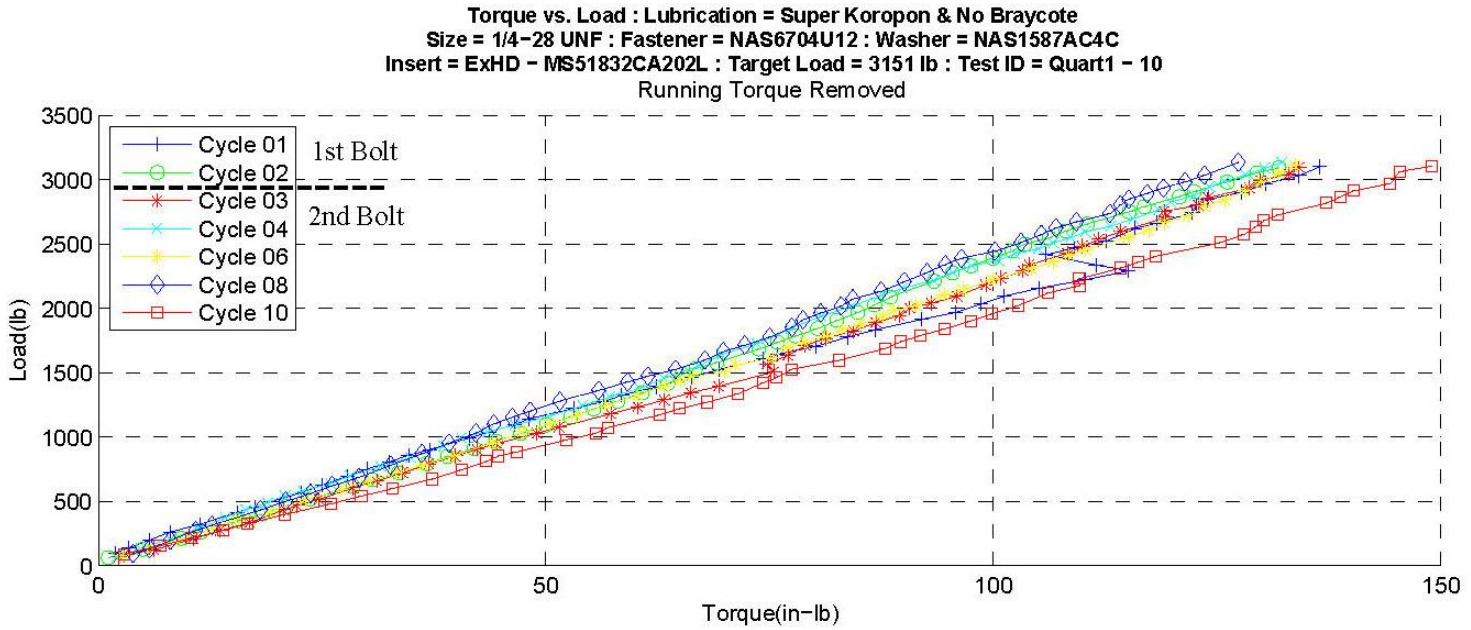
Tor Wrench Op: Mcleod
Data Sys. Op: Peil
Notes: FilenamePrefix: Ten 041-050 (T602B 011-020)
Fastener Spec: NAS6703U12
Washer Spec:
The torque wrench has a in-lb capacity
calibrated out to 300 in-lb
Torque Wrench: S/N:

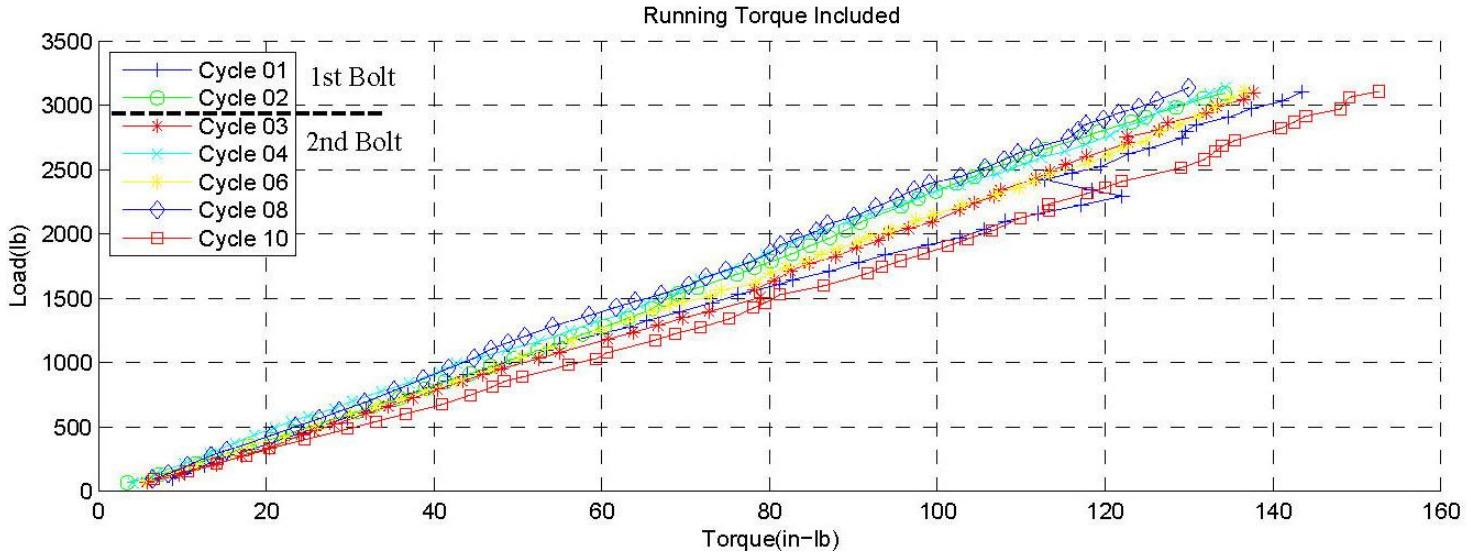
Cord	Cycle No.	Fastener Size	Target Load (lb)	Brk Torq (In-lb)	Lubrication Type			Comments	Breakaway Running Torq (In-lb)
					None	Braycote 601	Braycote 602		
2,1	1	#10-32	1763	27.5			X		5
2,1	2	#10-32	1763	22.5			X		3
2,1	3	#10-32	1763	24			X		2.8
2,1	4	#10-32	1763	24.5			X		2.5
2,1	5	#10-32	1763	23			X		2
2,1	6	#10-32	1763	23.5			X		2.5
2,1	7	#10-32	1763	21			X		2
2,1	8	#10-32	1763	21.5			X		2
2,1	9	#10-32	1763	18			X		1.8
2,1	10	#10-32	1763	21			X		2

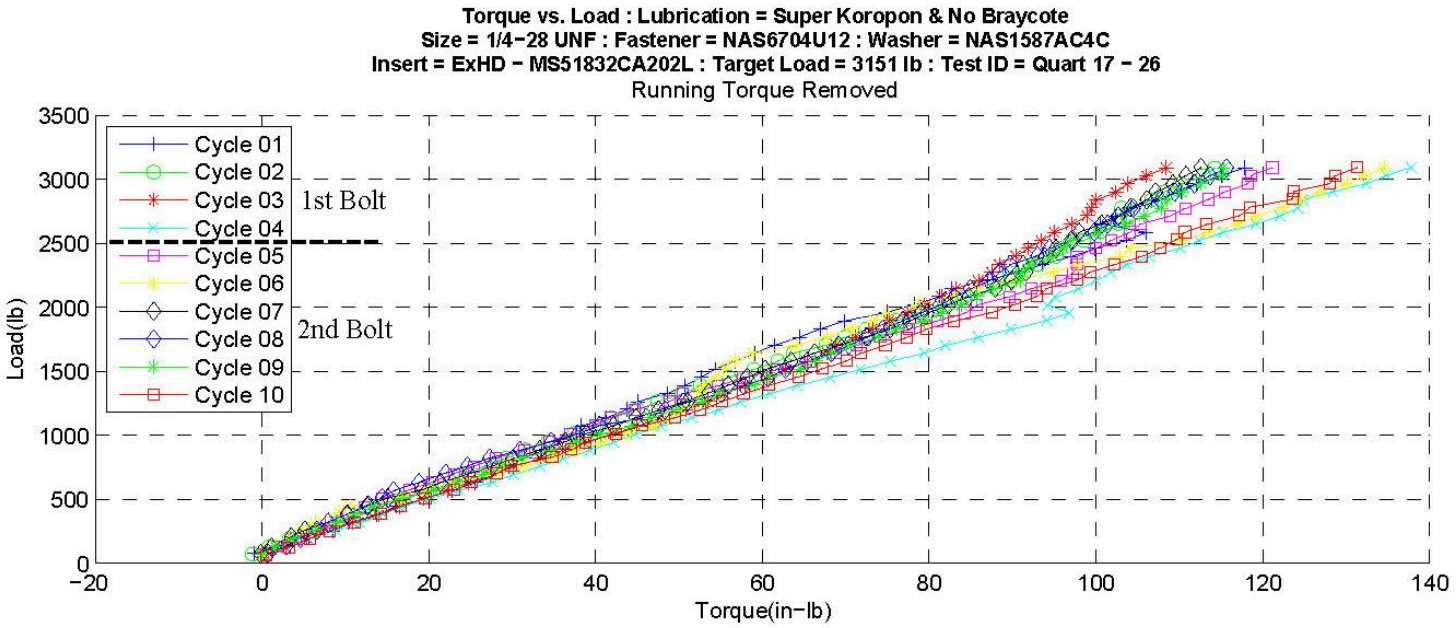
Appendix D – Full set of 1/4 - 28 Torque Tension and Running Torque Plots for ten cycles per insert, Excel® Torque Coefficient Data at 65% Pre Load, Test Plate Layouts and complete set of Run Logs.

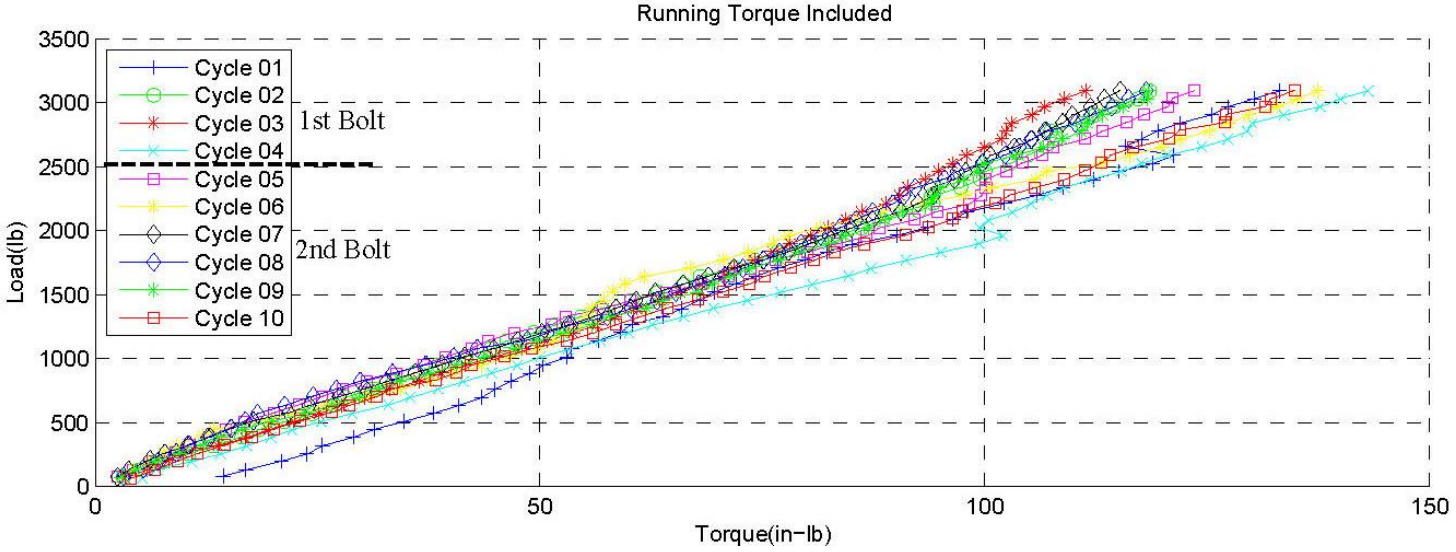
Appendix D:

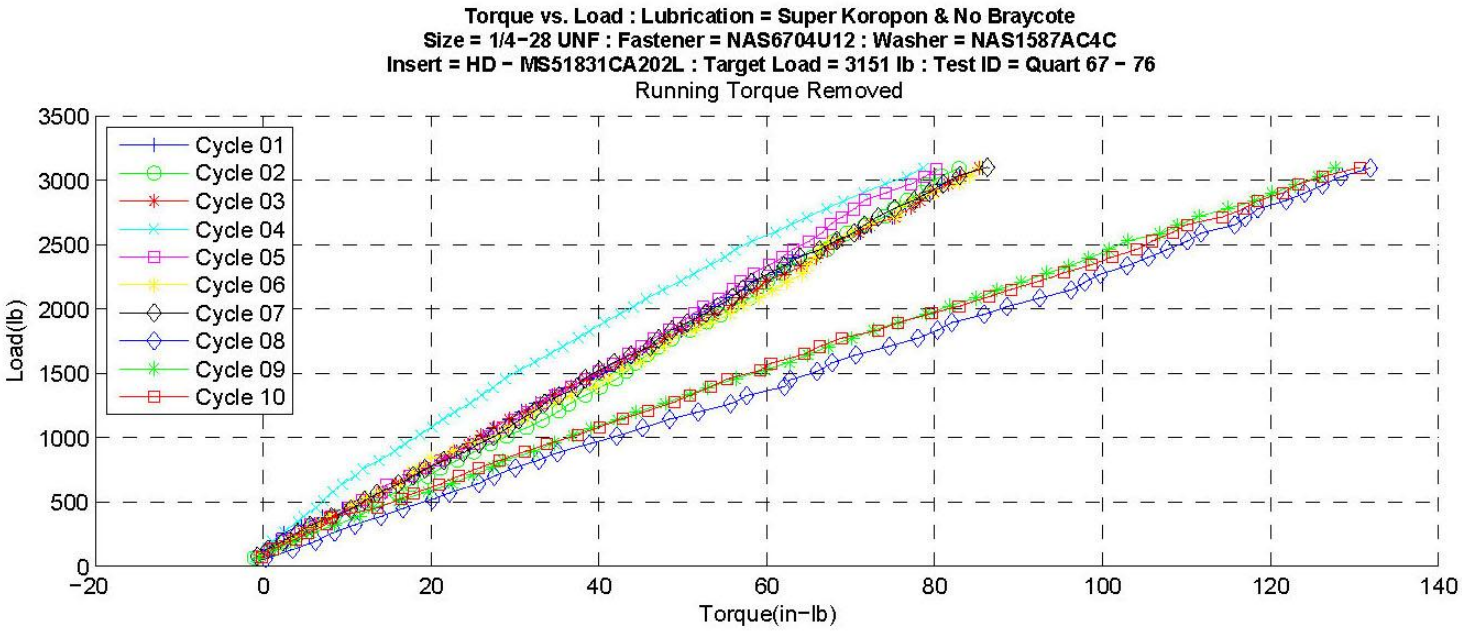
Section 1	1/4-28 No Braycote Torque Tension Plots
Section 2	1/4-28 Braycote 601 Torque Tension Plots
Section 3	1/4-28 Braycote 602 Torque Tension Plots
Section 4	1/4-28 No Braycote Running Torque Plots
Section 5	1/4-28 Braycote 601 Running Torque Plots
Section 6	1/4-28 Braycote 602 Running Torque Plots
Section 7	1/4-28 No Braycote Cycle Plots: Torque v. Load
Section 8	1/4-28 Braycote 601 Cycle Plots: Torque v. Load
Section 9	1/4-28 Braycote 602 Cycle Plots: Torque v. Load
Section 10	1/4-28 Friction Coefficients with Statistics
Section 11	1/4-28 Test Plate Layouts
Section 12	1/4-28 No Braycote Run Log
Section 13	1/4-28 Braycote 601 Run Logs
Section 14	1/4-28 Braycote 602 Run Logs

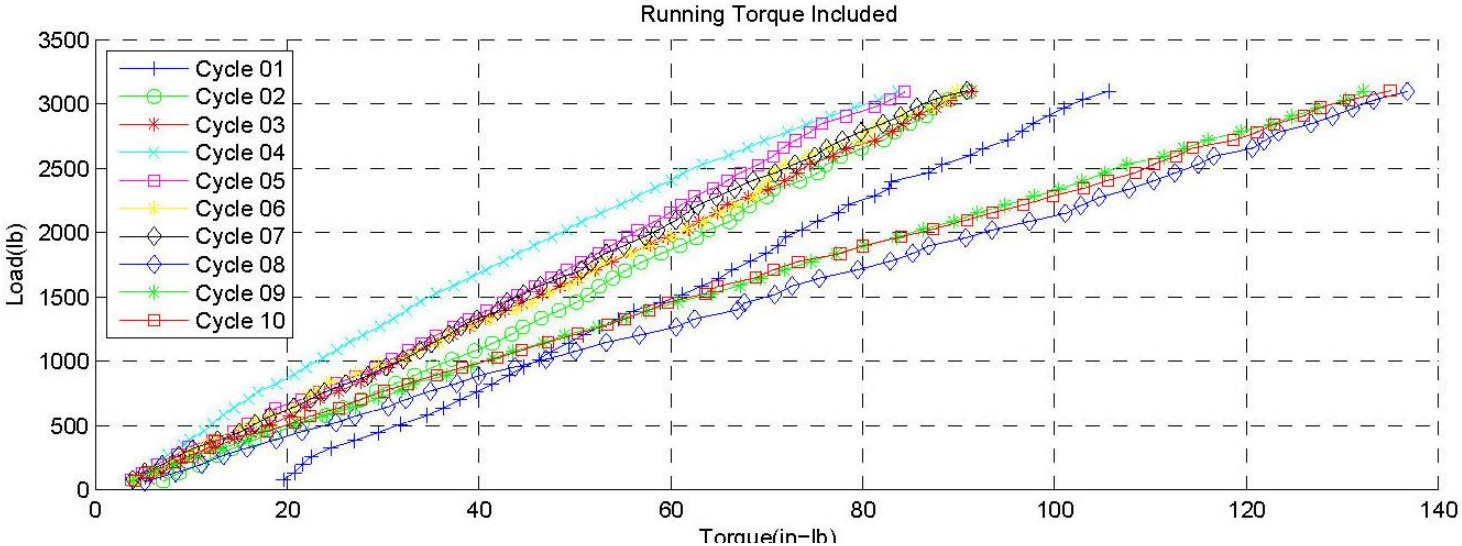

Torque vs. Load : Lubrication = Super Koropon & No Braycote
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Washer = NAS1587AC4C
Insert = ExHD - MS51832CA202L : Target Load = 3151 lb : Test ID = Quart1 - 10
Running Torque Removed
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 06
Cycle 08
Cycle 10
1st Bolt
2nd Bolt
Load(lb)
Torque(in-lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150

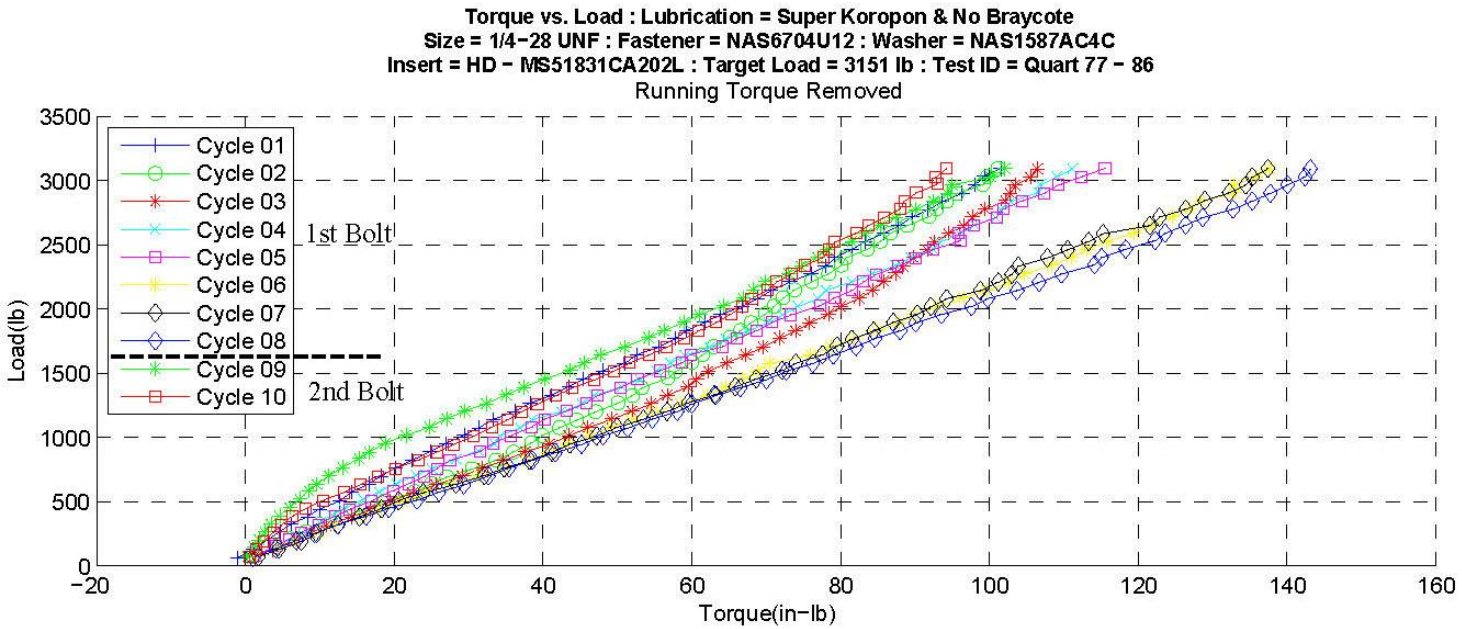

Running Torque Included
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 06
Cycle 08
Cycle 10
1st Bolt
2nd Bolt
Load(lb)
Torque(in-lb)
0
500
1000
1500
2000
2500
3000
3500
0
20
40
60
80
100
120
140
160

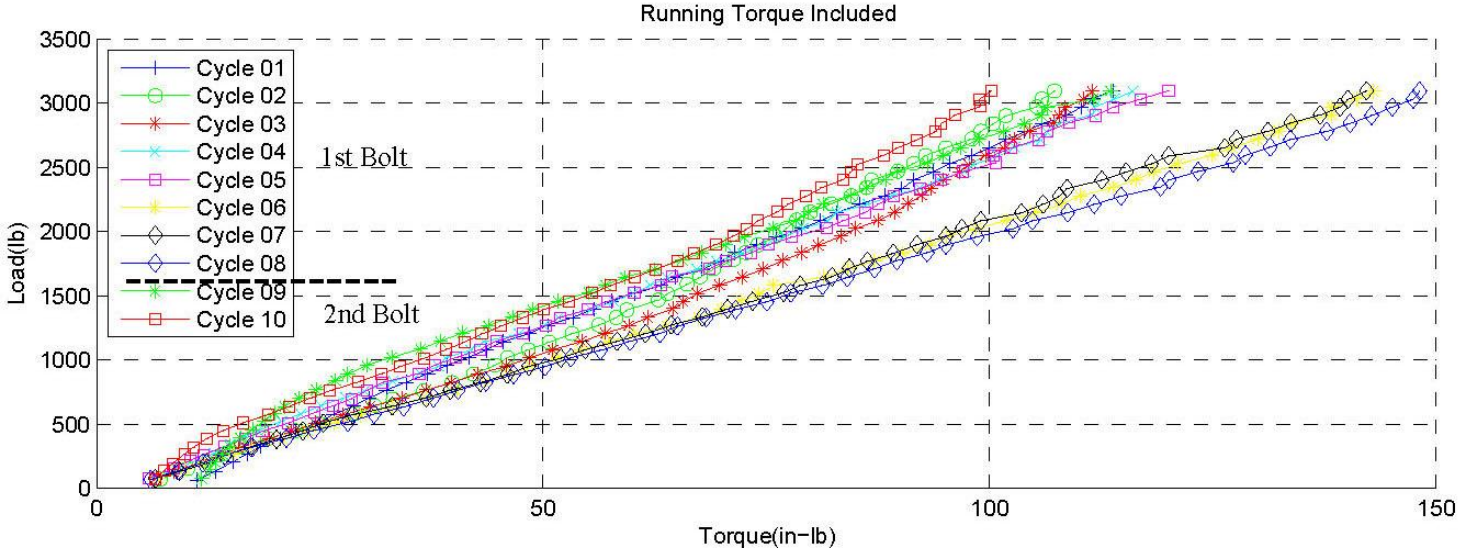

Torque vs. Load : Lubrication = Super Koropon & No Braycote
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Washer = NAS1587AC4C
Insert = ExHD - MS51832CA202L : Target Load = 3151 lb : Test ID = Quart 17 - 26
Running Torque Removed
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10
1st Bolt
2nd Bolt
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
-20
0
20
40
60
80
100
120
140

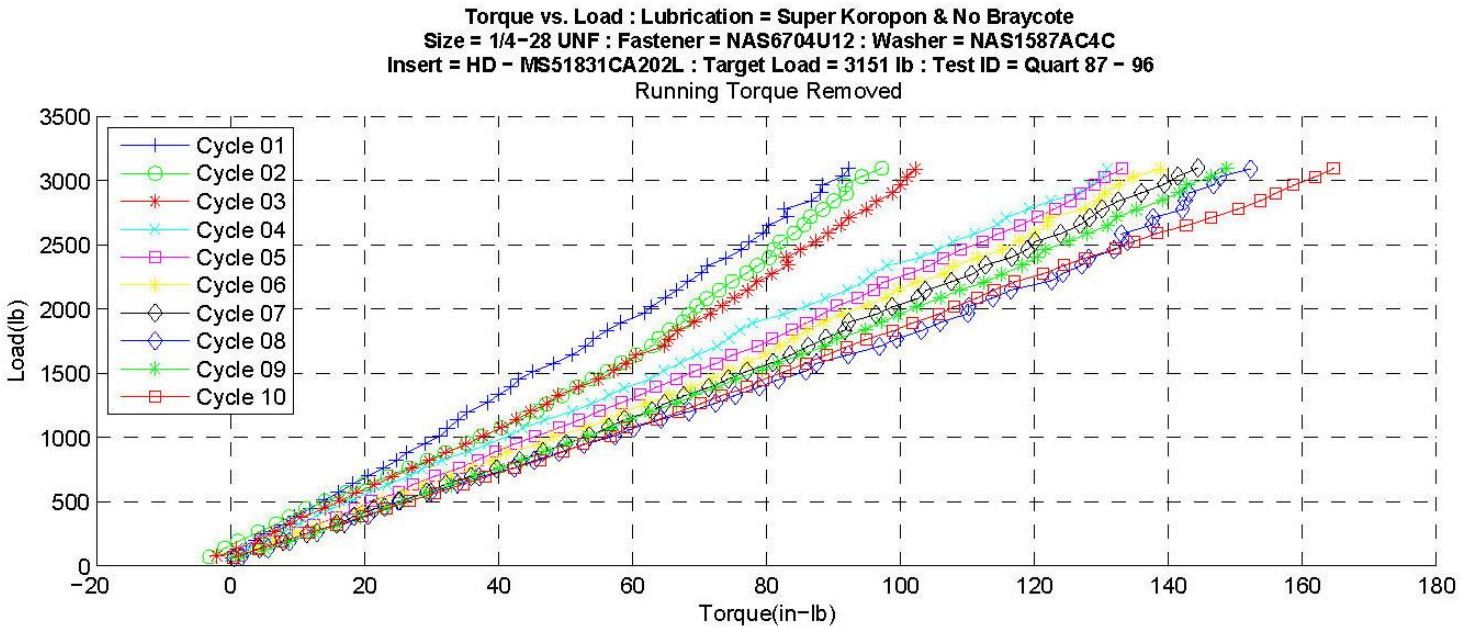

Running Torque Included
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10
1st Bolt
2nd Bolt
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
0
50
100
150

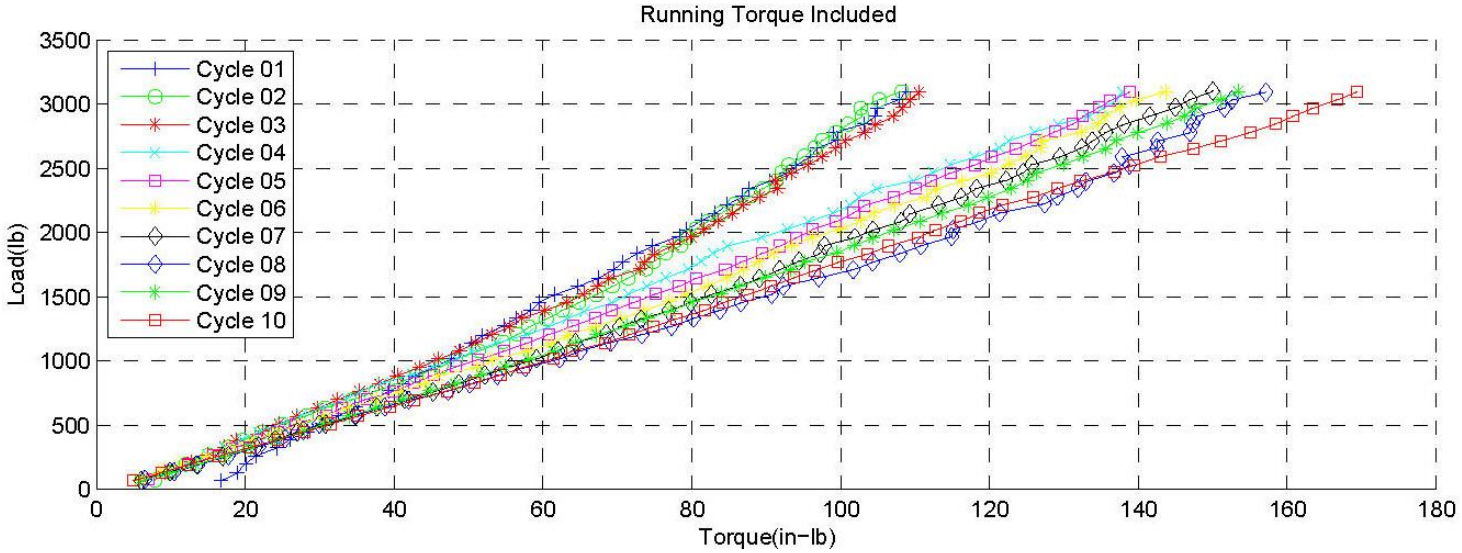

Torque vs. Load : Lubrication = Super Koropon & No Braycote
Size = 1/4−28 UNF : Fastener = NAS6704U12 : Washer = NAS1587AC4C
Insert = HD − MS51831CA202L : Target Load = 3151 lb : Test ID = Quart 67 − 76
Running Torque Removed
Load(lb)
Torque(in−lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10


Running Torque Included
Load(lb)
Torque(in−lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10


Torque vs. Load : Lubrication = Super Koropon & No Braycote
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Washer = NAS1587AC4C
Insert = HD - MS51831CA202L : Target Load = 3151 lb : Test ID = Quart 77 - 86
Running Torque Removed
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10
1st Bolt
2nd Bolt
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
-20
0
20
40
60
80
100
120
140
160

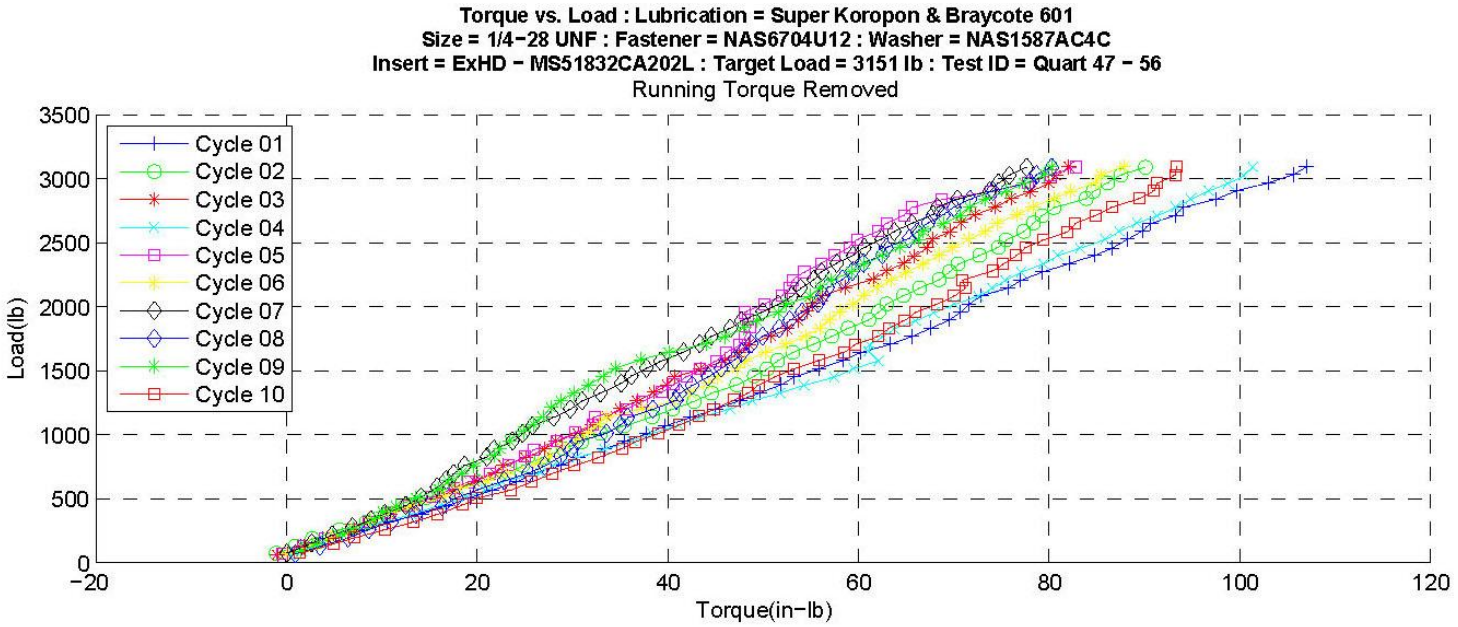

Running Torque Included
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10
1st Bolt
2nd Bolt
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
0
50
100
150

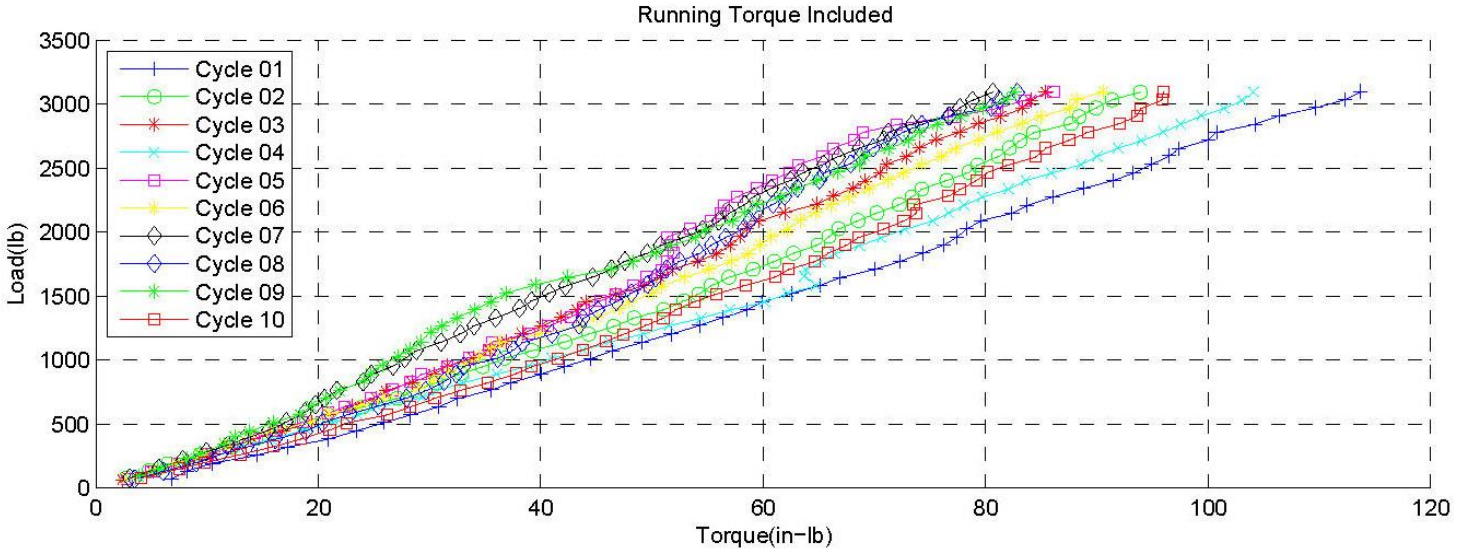

Torque vs. Load : Lubrication = Super Koropon & No Braycote
Size = 1/4−28 UNF : Fastener = NAS6704U12 : Washer = NAS1587AC4C
Insert = HD − MS51831CA202L : Target Load = 3151 lb : Test ID = Quart 87 − 96
Running Torque Removed
Load(lb)
Torque(in−lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10

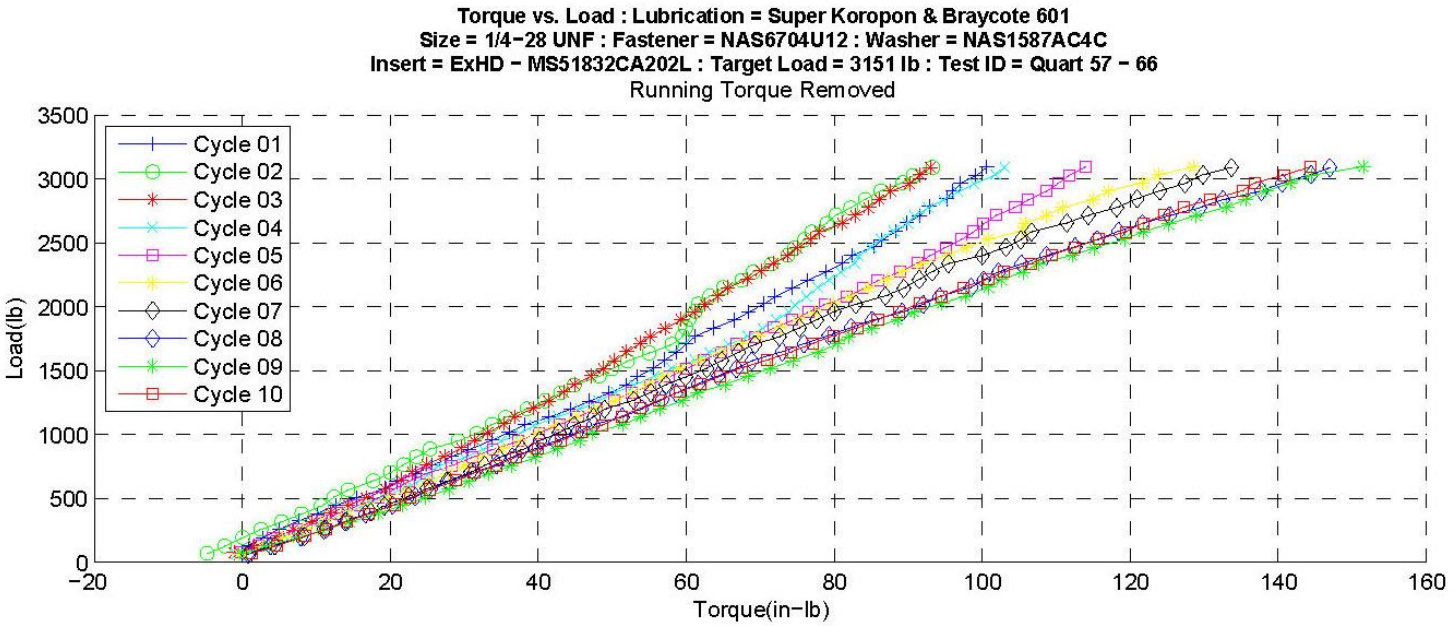

Running Torque Included
Load(lb)
Torque(in−lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10

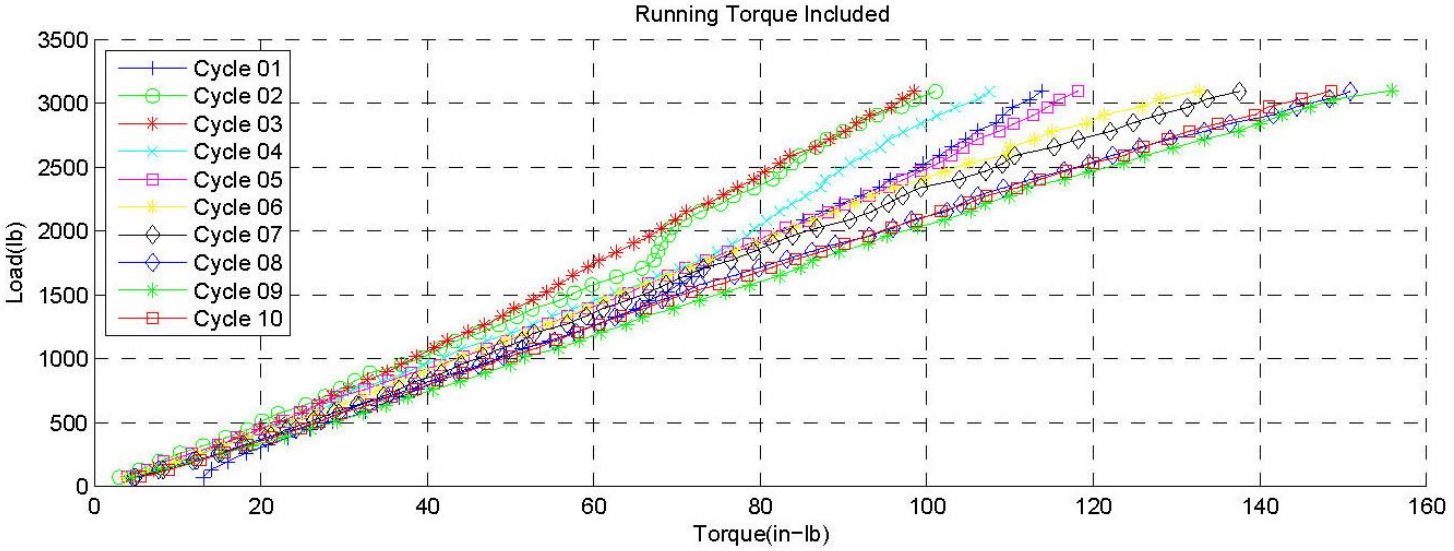
Appendix D:

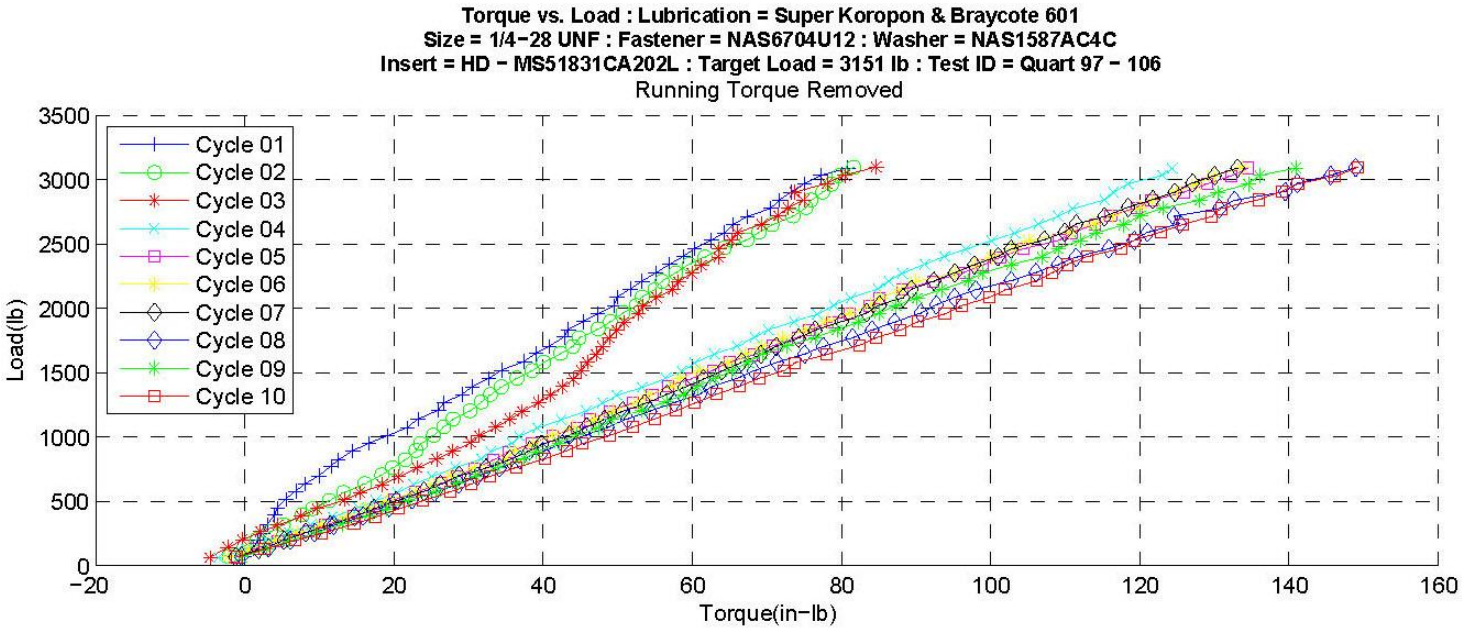
Section 1	1/4-28 No Braycote Torque Tension Plots
Section 2	1/4-28 Braycote 601 Torque Tension Plots
Section 3	1/4-28 Braycote 602 Torque Tension Plots
Section 4	1/4-28 No Braycote Running Torque Plots
Section 5	1/4-28 Braycote 601 Running Torque Plots
Section 6	1/4-28 Braycote 602 Running Torque Plots
Section 7	1/4-28 No Braycote Cycle Plots: Torque v. Load
Section 8	1/4-28 Braycote 601 Cycle Plots: Torque v. Load
Section 9	1/4-28 Braycote 602 Cycle Plots: Torque v. Load
Section 10	1/4-28 Friction Coefficients with Statistics
Section 11	1/4-28 Test Plate Layouts
Section 12	1/4-28 No Braycote Run Log
Section 13	1/4-28 Braycote 601 Run Logs
Section 14	1/4-28 Braycote 602 Run Logs

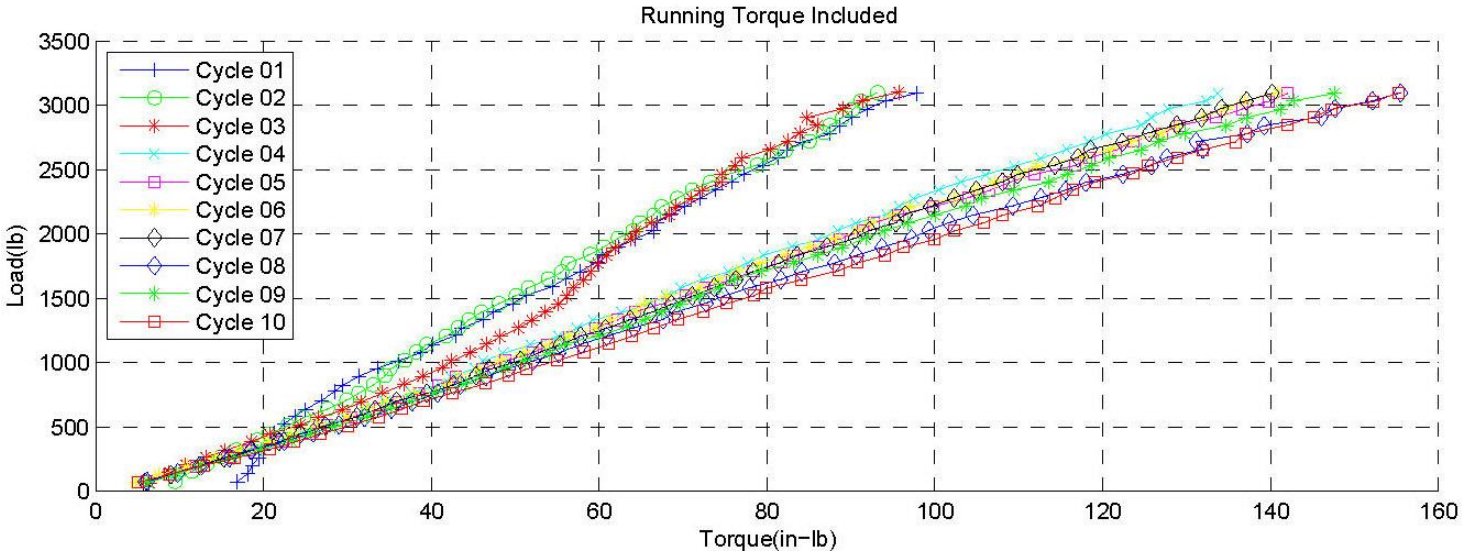

Torque vs. Load : Lubrication = Super Koropon & Braycote 601
Size = 1/4−28 UNF : Fastener = NAS6704U12 : Washer = NAS1587AC4C
Insert = ExHD − MS51832CA202L : Target Load = 3151 lb : Test ID = Quart 47 − 56
Running Torque Removed
Load(lb)
Torque(in−lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10

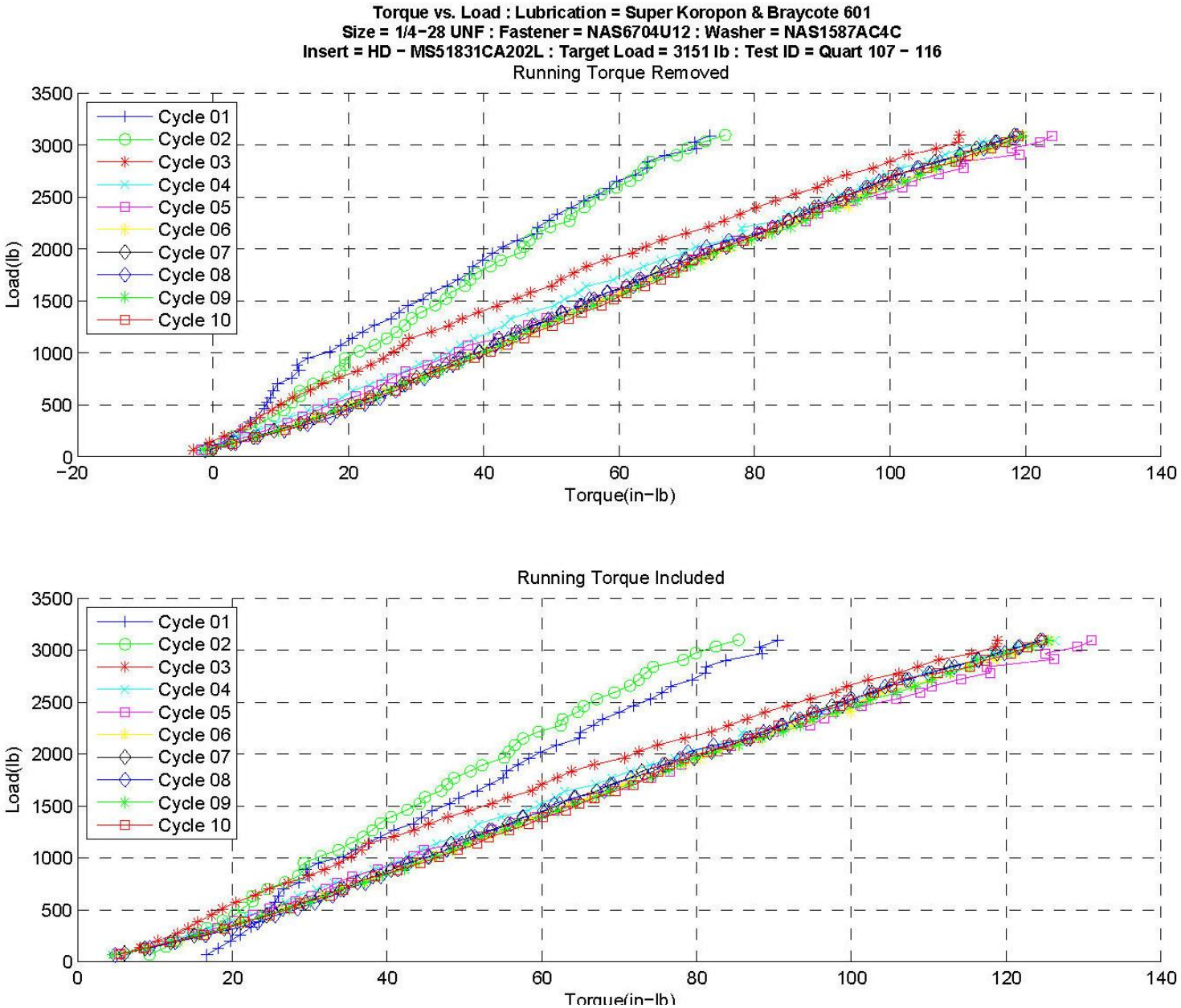

Running Torque Included
Load(lb)
Torque(in−lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10

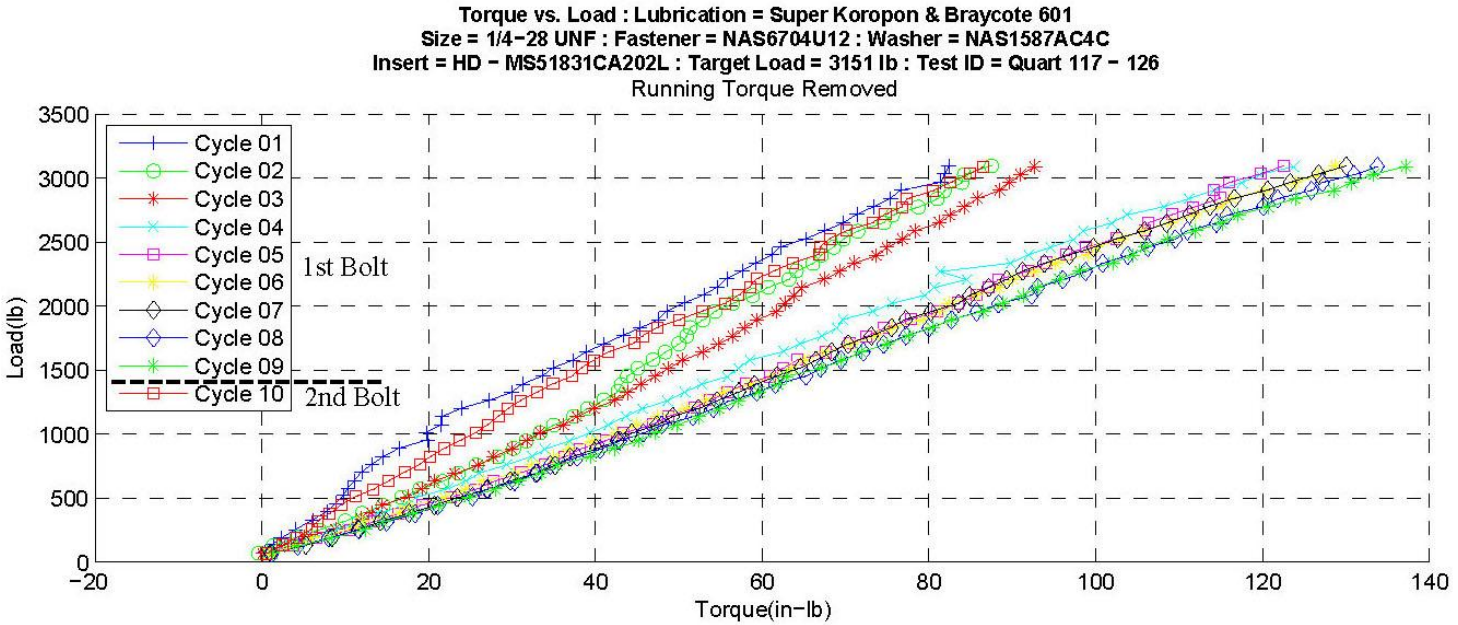

Torque vs. Load : Lubrication = Super Koropon & Braycote 601
Size = 1/4−28 UNF : Fastener = NAS6704U12 : Washer = NAS1587AC4C
Insert = ExHD − MS51832CA202L : Target Load = 3151 lb : Test ID = Quart 57 − 66
Running Torque Removed
Load(lb)
Torque(in−lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10

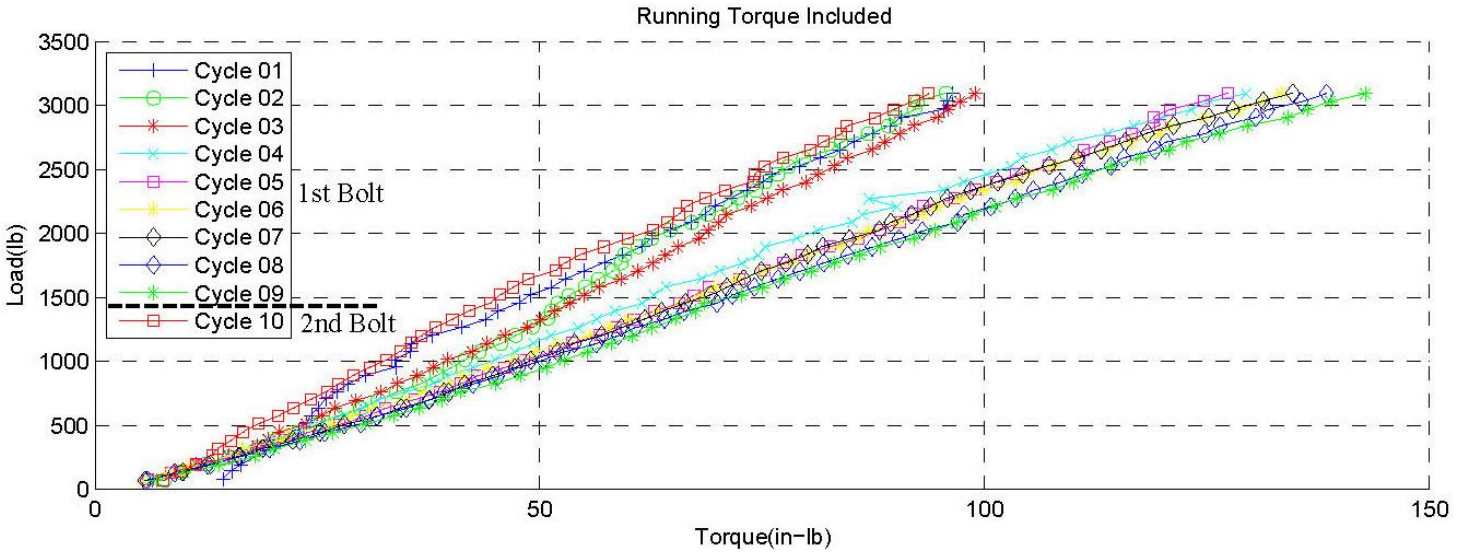

Running Torque Included
Load(lb)
Torque(in−lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10


Torque vs. Load : Lubrication = Super Koropon & Braycote 601
Size = 1/4−28 UNF : Fastener = NAS6704U12 : Washer = NAS1587AC4C
Insert = HD − MS51831CA202L : Target Load = 3151 lb : Test ID = Quart 97 − 106
Running Torque Removed
Load(lb)
Torque(in−lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10


Running Torque Included
Load(lb)
Torque(in−lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10

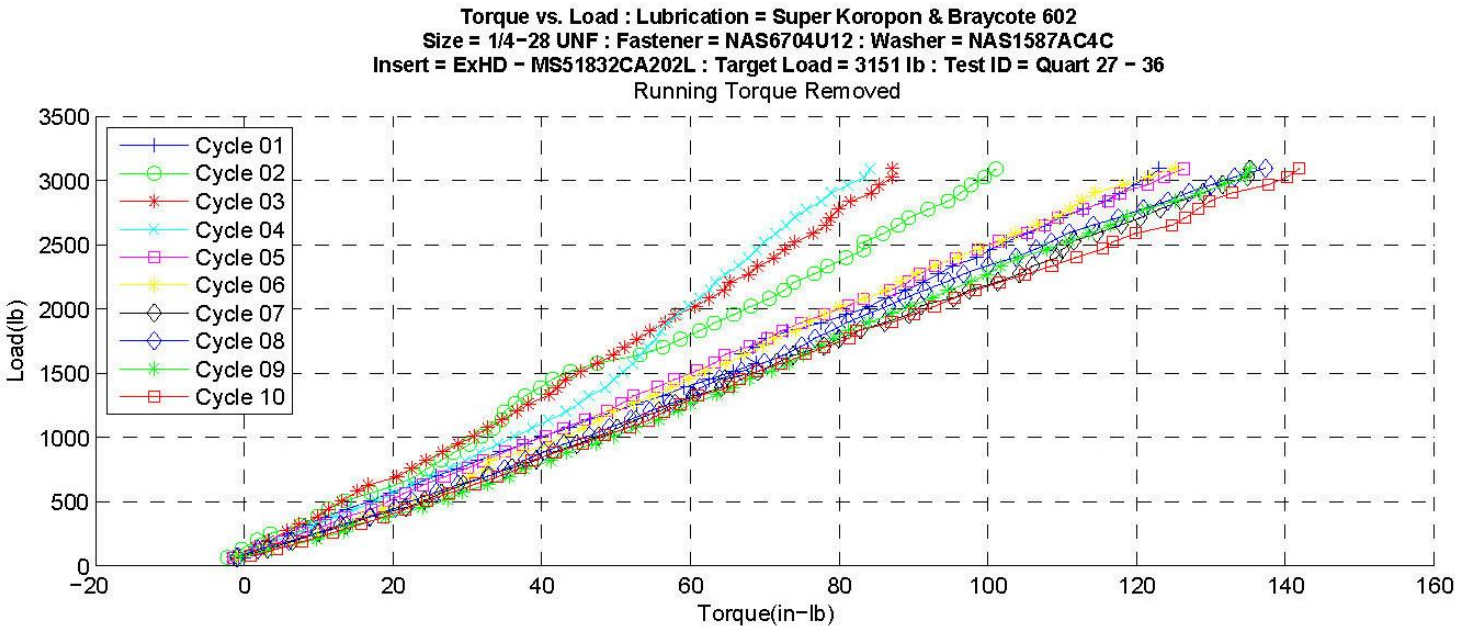

Torque vs. Load : Lubrication = Super Koropon & Braycote 601
Size = 1/4−28 UNF : Fastener = NAS6704U12 : Washer = NAS1587AC4C
Insert = HD − MS51831CA202L : Target Load = 3151 lb : Test ID = Quart 107 − 116
Running Torque Removed
Load(lb)
Torque(in−lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10
Running Torque Included
Load(lb)
Torque(in−lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10

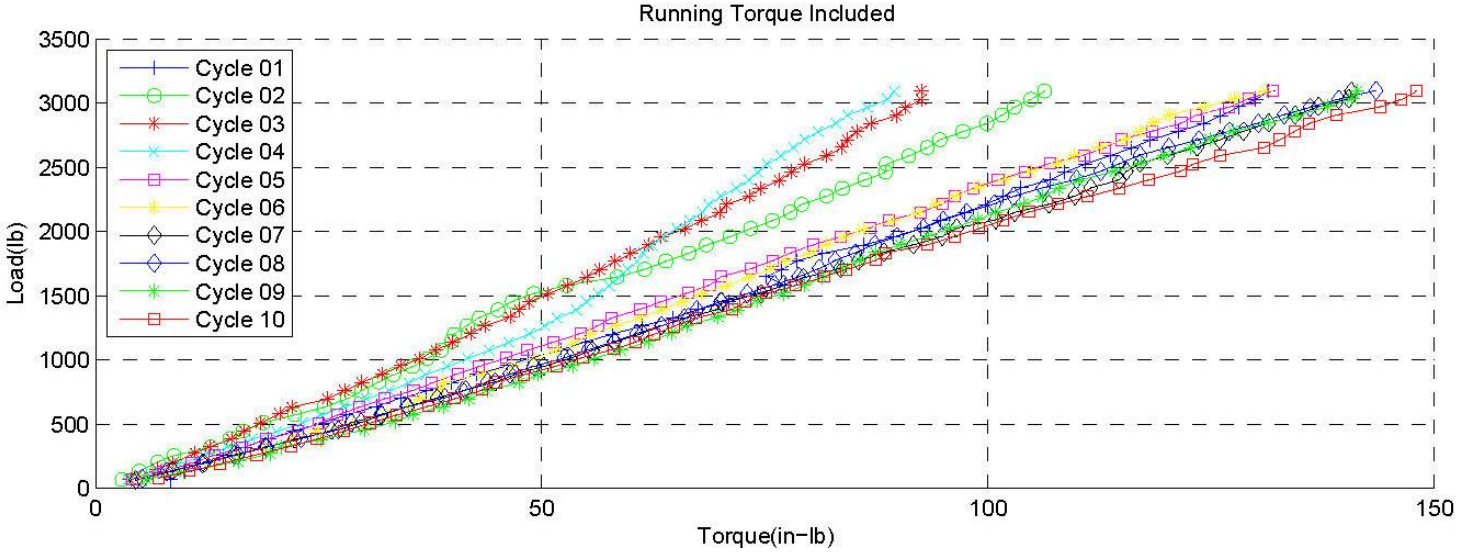

Torque vs. Load : Lubrication = Super Koropon & Braycote 601
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Washer = NAS1587AC4C
Insert = HD - MS51831CA202L : Target Load = 3151 lb : Test ID = Quart 117 - 126
Running Torque Removed
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10
1st Bolt
2nd Bolt
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
-20
0
20
40
60
80
100
120
140

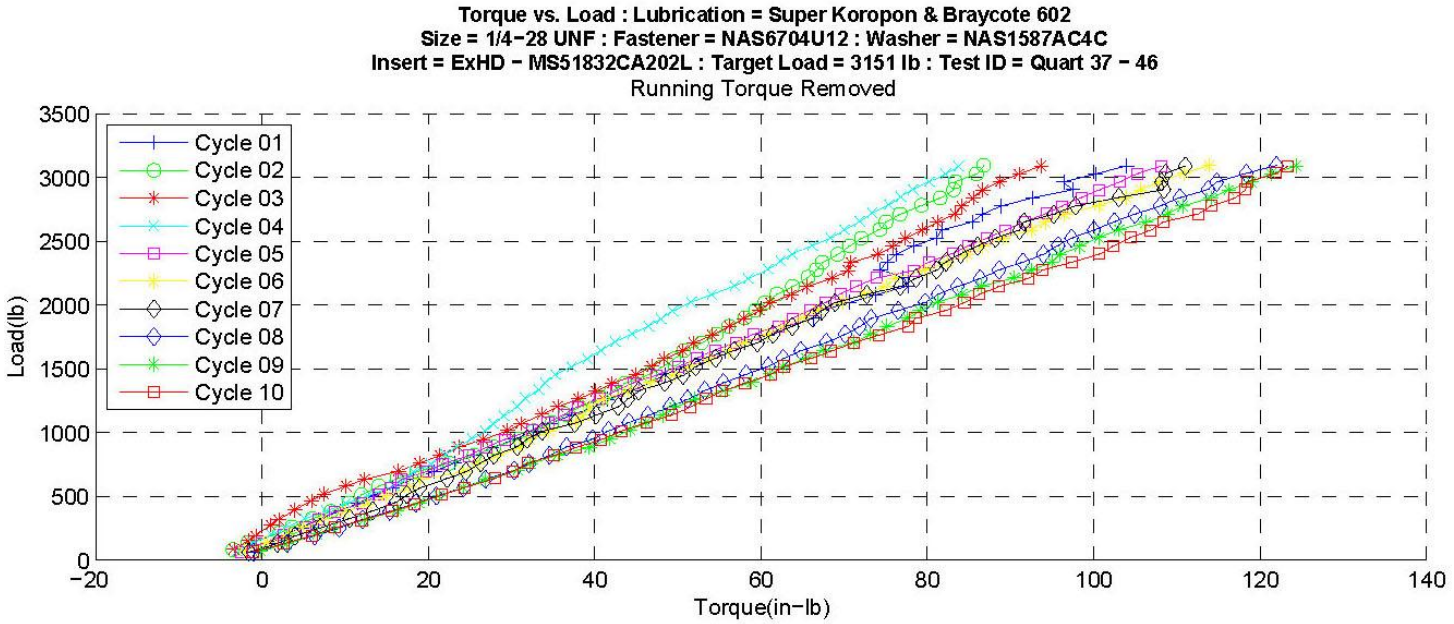

Running Torque Included
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10
1st Bolt
2nd Bolt
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
0
50
100
150

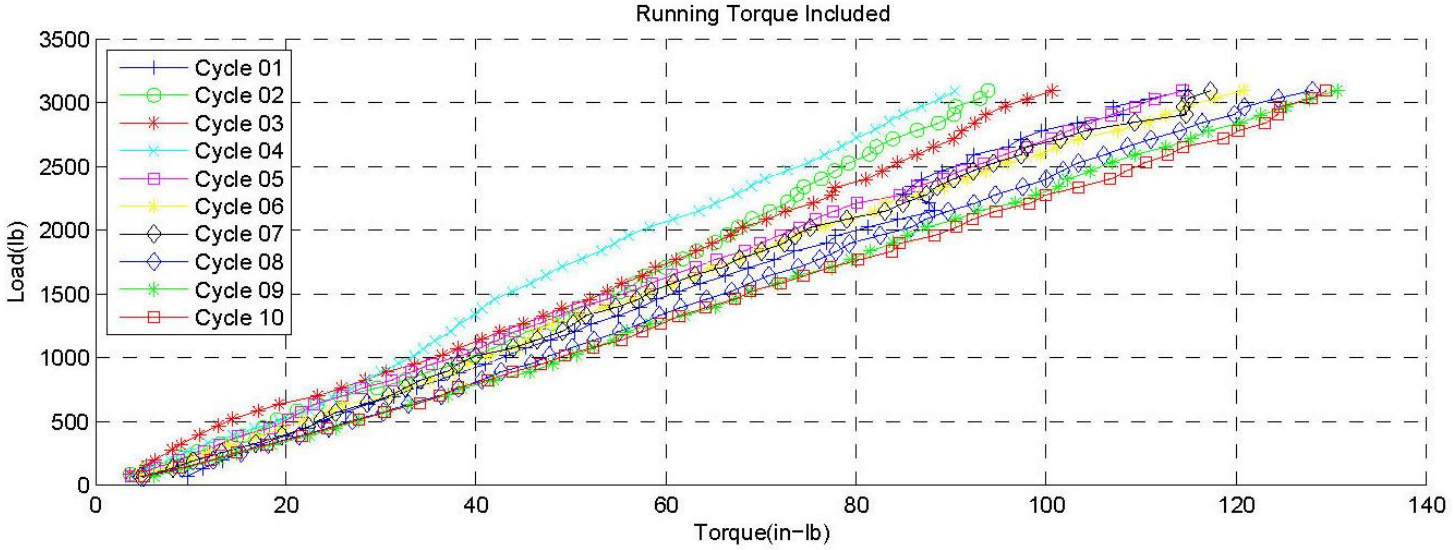
Appendix D:

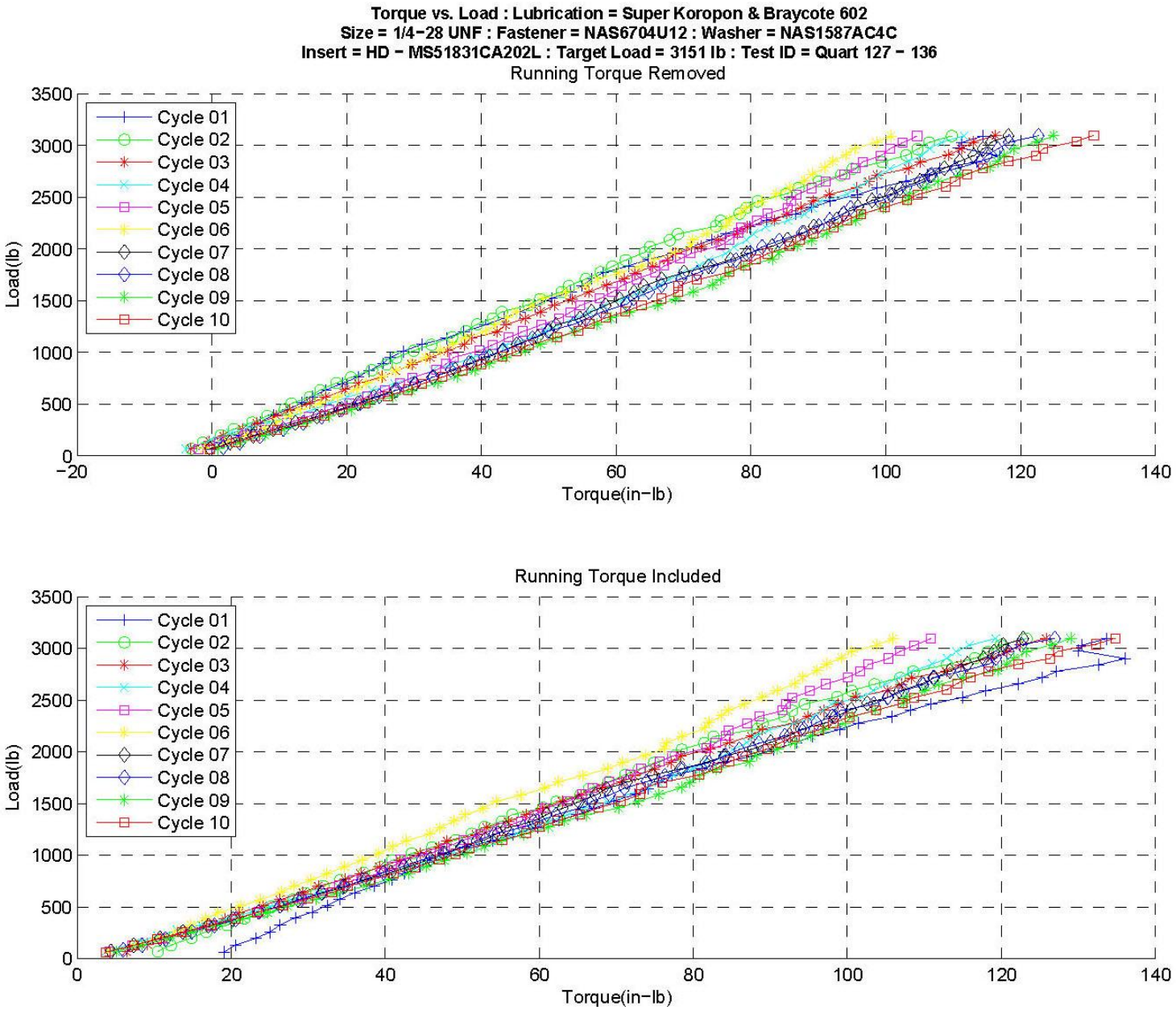
Section 1	1/4-28 No Braycote Torque Tension Plots
Section 2	1/4-28 Braycote 601 Torque Tension Plots
Section 3	1/4-28 Braycote 602 Torque Tension Plots
Section 4	1/4-28 No Braycote Running Torque Plots
Section 5	1/4-28 Braycote 601 Running Torque Plots
Section 6	1/4-28 Braycote 602 Running Torque Plots
Section 7	1/4-28 No Braycote Cycle Plots: Torque v. Load
Section 8	1/4-28 Braycote 601 Cycle Plots: Torque v. Load
Section 9	1/4-28 Braycote 602 Cycle Plots: Torque v. Load
Section 10	1/4-28 Friction Coefficients with Statistics
Section 11	1/4-28 Test Plate Layouts
Section 12	1/4-28 No Braycote Run Log
Section 13	1/4-28 Braycote 601 Run Logs
Section 14	1/4-28 Braycote 602 Run Logs

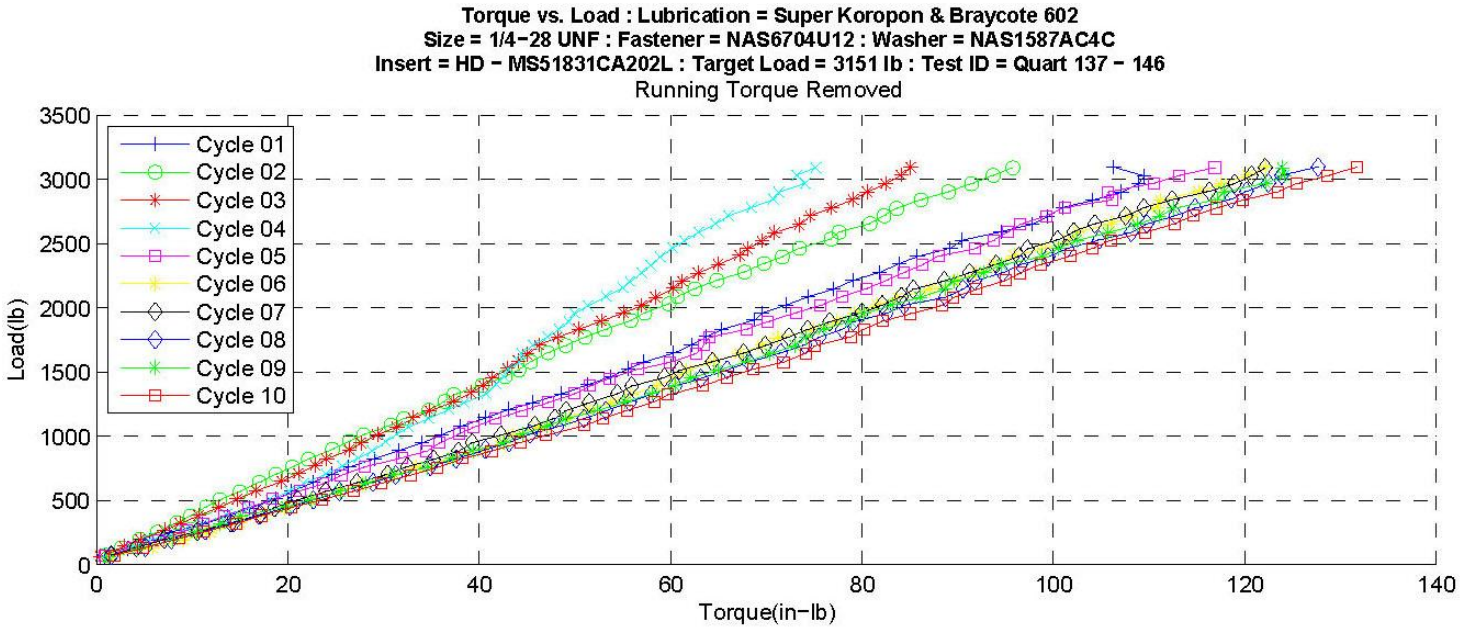

Torque vs. Load : Lubrication = Super Koropon & Braycote 602
Size = 1/4−28 UNF : Fastener = NAS6704U12 : Washer = NAS1587AC4C
Insert = ExHD − MS51832CA202L : Target Load = 3151 lb : Test ID = Quart 27 − 36
Running Torque Removed
Load(lb)
Torque(in−lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10

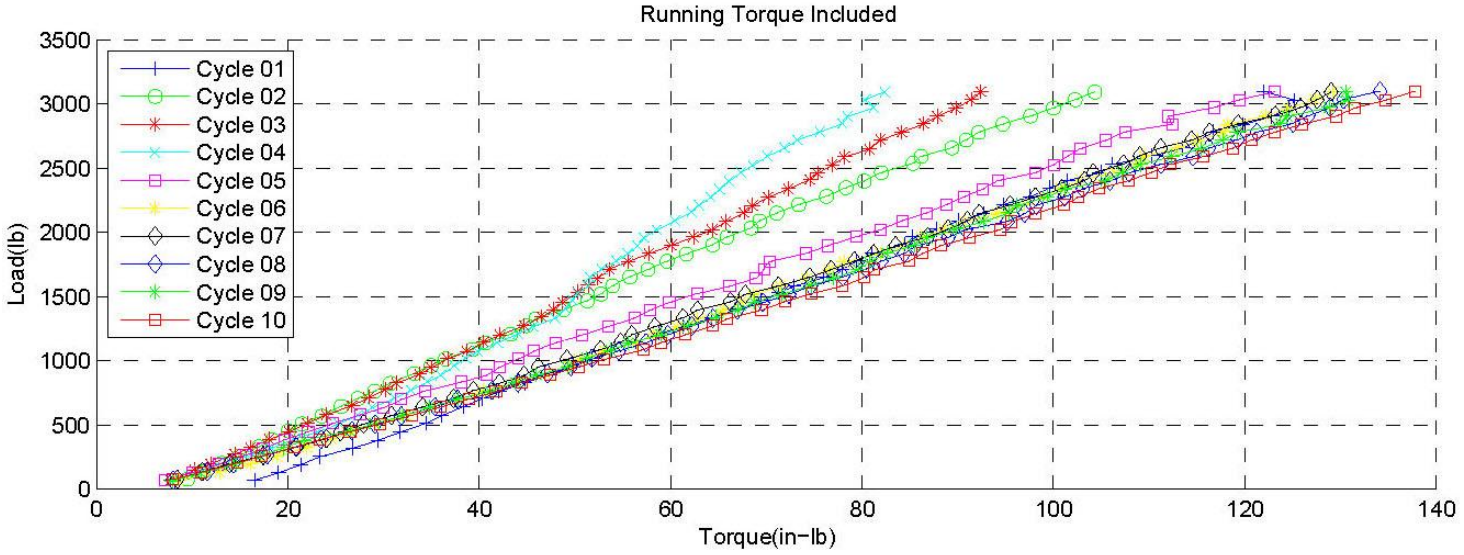

Running Torque Included
Load(lb)
Torque(in−lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10


Torque vs. Load : Lubrication = Super Koropon & Braycote 602
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Washer = NAS1587AC4C
Insert = ExHD - MS51832CA202L : Target Load = 3151 lb : Test ID = Quart 37 - 46
Running Torque Removed
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
-20
0
20
40
60
80
100
120
140


Running Torque Included
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
120
140

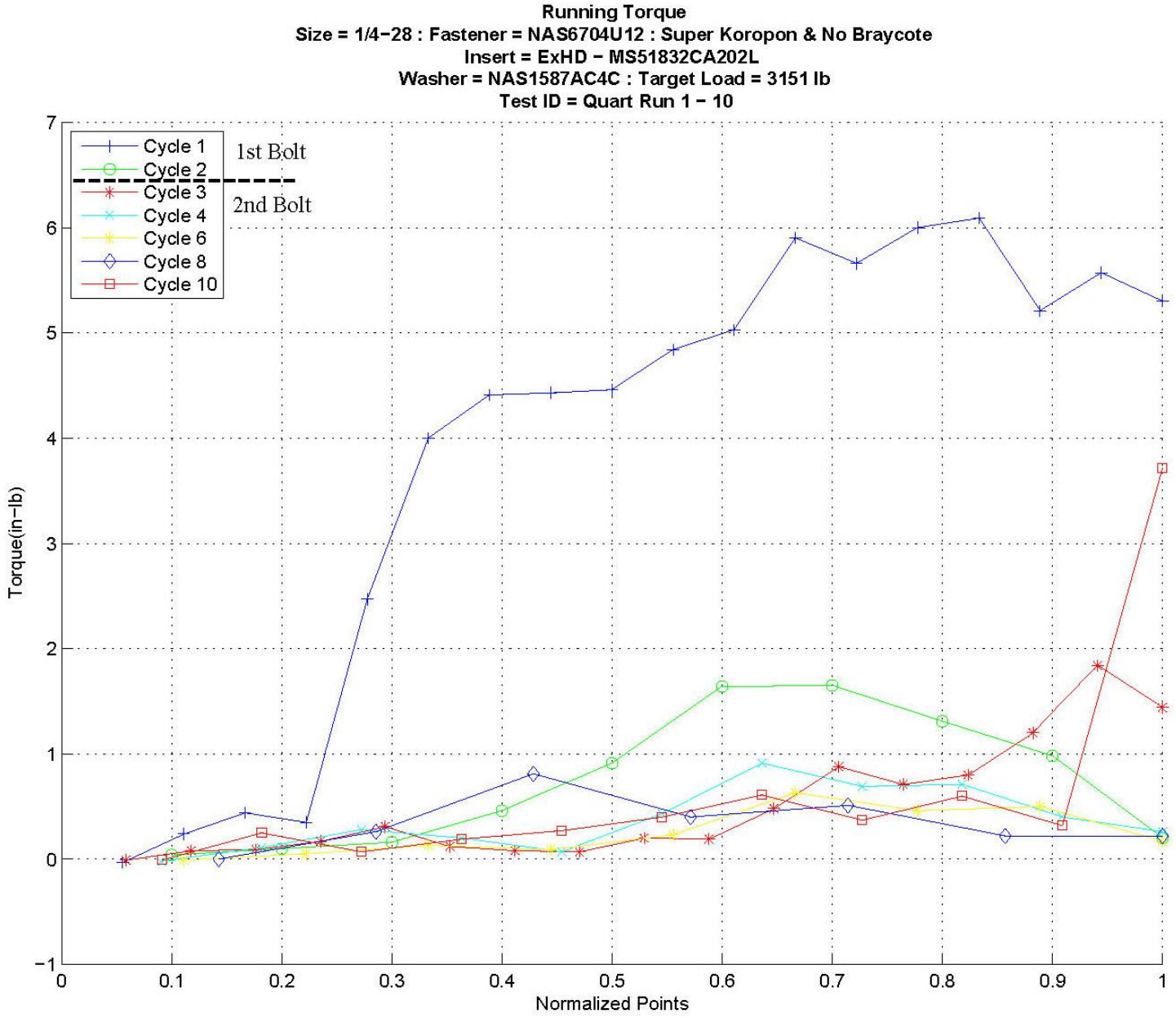

Torque vs. Load : Lubrication = Super Koropon & Braycote 602
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Washer = NAS1587AC4C
Insert = HD - MS51831CA202L : Target Load = 3151 lb : Test ID = Quart 127 - 136
Running Torque Removed
Load(lb)
Torque(in-lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10
Running Torque Included
Load(lb)
Torque(in-lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10

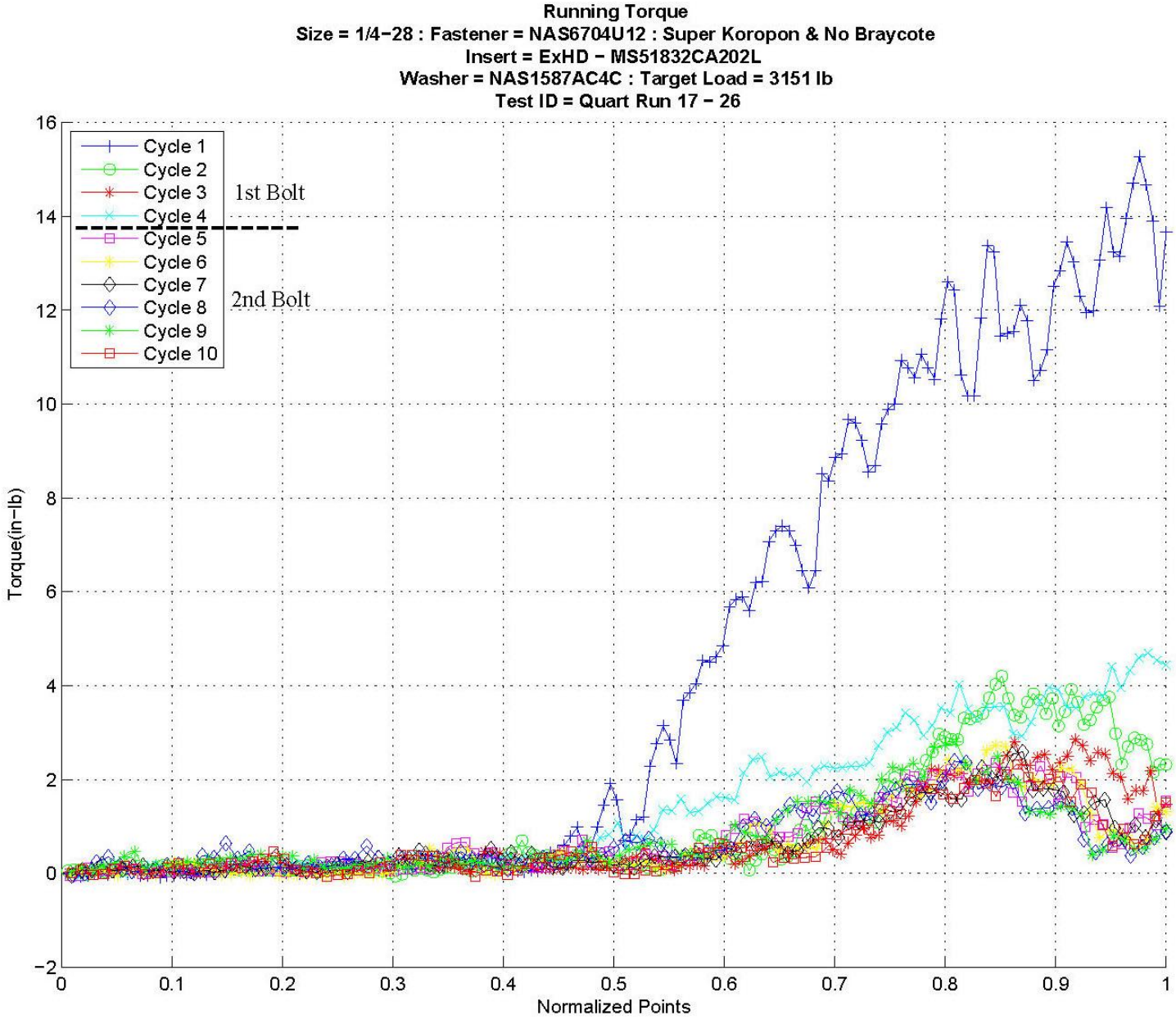

Torque vs. Load : Lubrication = Super Koropon & Braycote 602
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Washer = NAS1587AC4C
Insert = HD - MS51831CA202L : Target Load = 3151 lb : Test ID = Quart 137 - 146
Running Torque Removed
Load(lb)
Torque(in-lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10
0
500
1000
1500
2000
2500
3000
3500
0
20
40
60
80
100
120
140

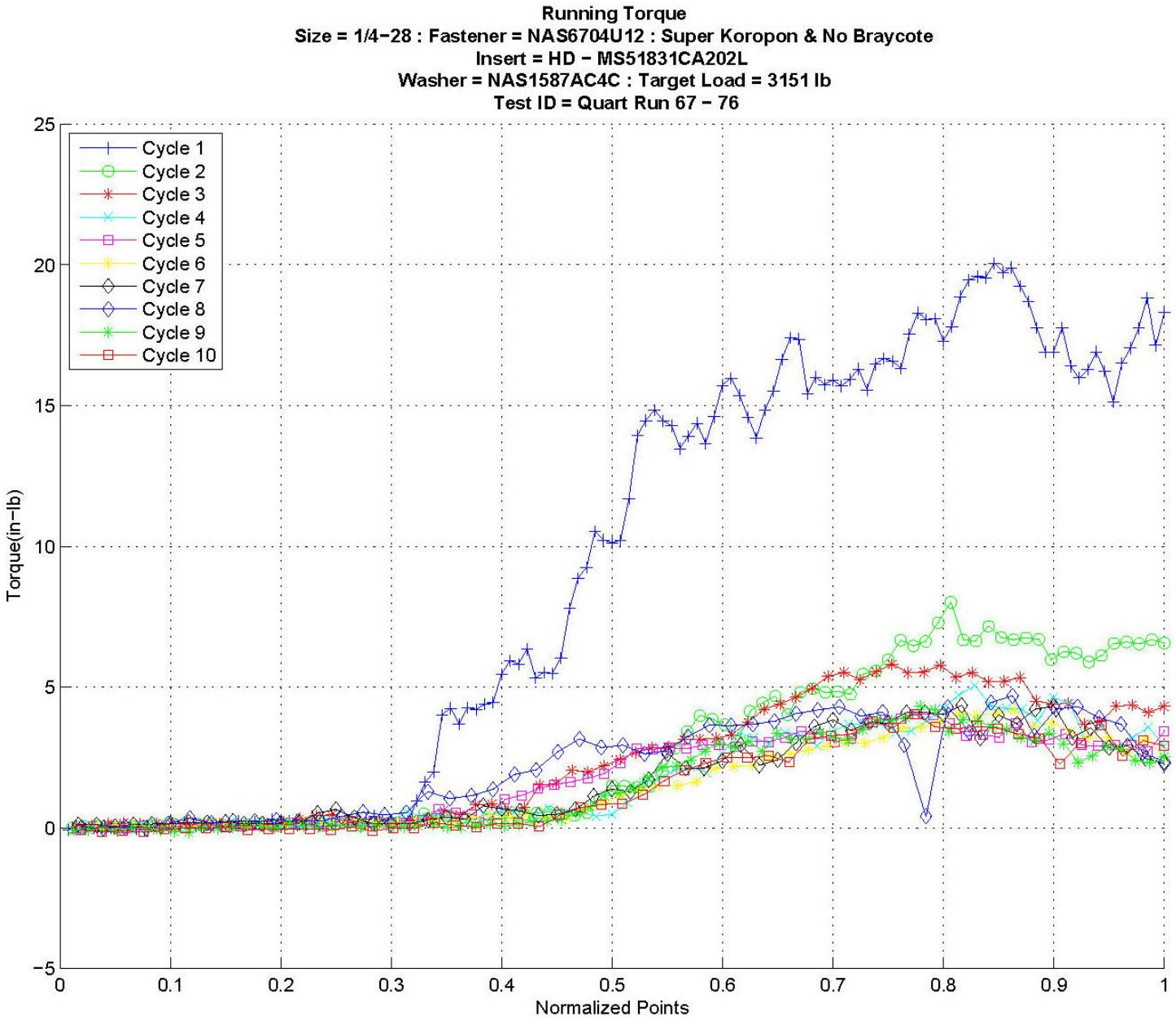

Running Torque Included
Load(lb)
Torque(in-lb)
Cycle 01
Cycle 02
Cycle 03
Cycle 04
Cycle 05
Cycle 06
Cycle 07
Cycle 08
Cycle 09
Cycle 10
0
500
1000
1500
2000
2500
3000
3500
0
20
40
60
80
100
120
140

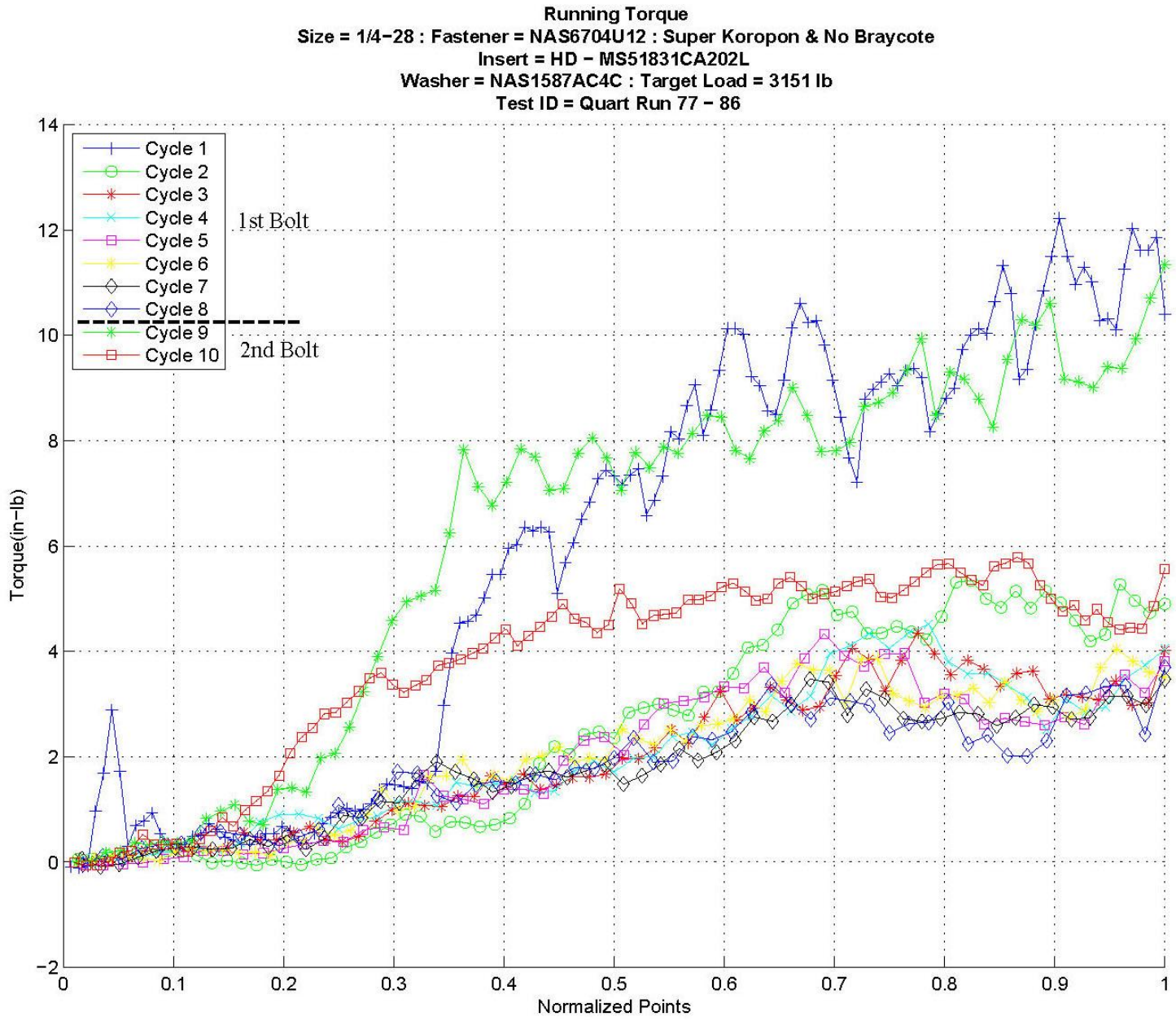
Appendix D:

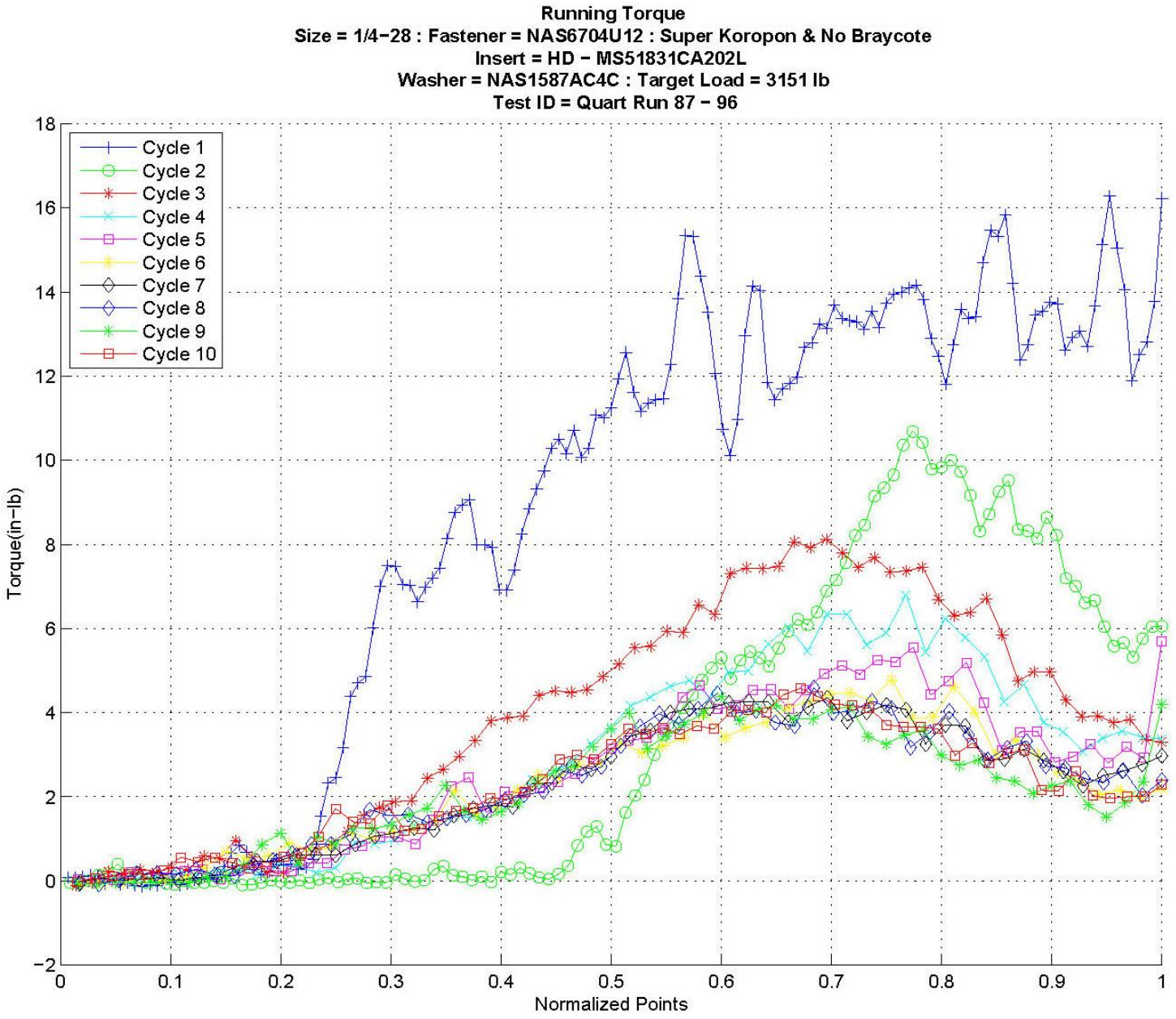
Section 1	1/4-28 No Braycote Torque Tension Plots
Section 2	1/4-28 Braycote 601 Torque Tension Plots
Section 3	1/4-28 Braycote 602 Torque Tension Plots
Section 4	1/4-28 No Braycote Running Torque Plots
Section 5	1/4-28 Braycote 601 Running Torque Plots
Section 6	1/4-28 Braycote 602 Running Torque Plots
Section 7	1/4-28 No Braycote Cycle Plots: Torque v. Load
Section 8	1/4-28 Braycote 601 Cycle Plots: Torque v. Load
Section 9	1/4-28 Braycote 602 Cycle Plots: Torque v. Load
Section 10	1/4-28 Friction Coefficients with Statistics
Section 11	1/4-28 Test Plate Layouts
Section 12	1/4-28 No Braycote Run Log
Section 13	1/4-28 Braycote 601 Run Logs
Section 14	1/4-28 Braycote 602 Run Logs


Running Torque
Size = 1/4-28 : Fastener = NAS6704U12 : Super Koropon & No Braycote
Insert = ExHD - MS51832CA202L
Washer = NAS1587AC4C : Target Load = 3151 lb
Test ID = Quart Run 1 - 10
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 6
Cycle 8
Cycle 10
1st Bolt
2nd Bolt
Torque(in-lb)
Normalized Points
7
6
5
4
3
2
1
0
-1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


Running Torque
Size = 1/4-28 : Fastener = NAS6704U12 : Super Koropon & No Braycote
Insert = ExHD - MS51832CA202L
Washer = NAS1587AC4C : Target Load = 3151 lb
Test ID = Quart Run 17 - 26
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Cycle 7
Cycle 8
Cycle 9
Cycle 10
1st Bolt
2nd Bolt
Torque(in-lb)
Normalized Points
16
14
12
10
8
6
4
2
0
-2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

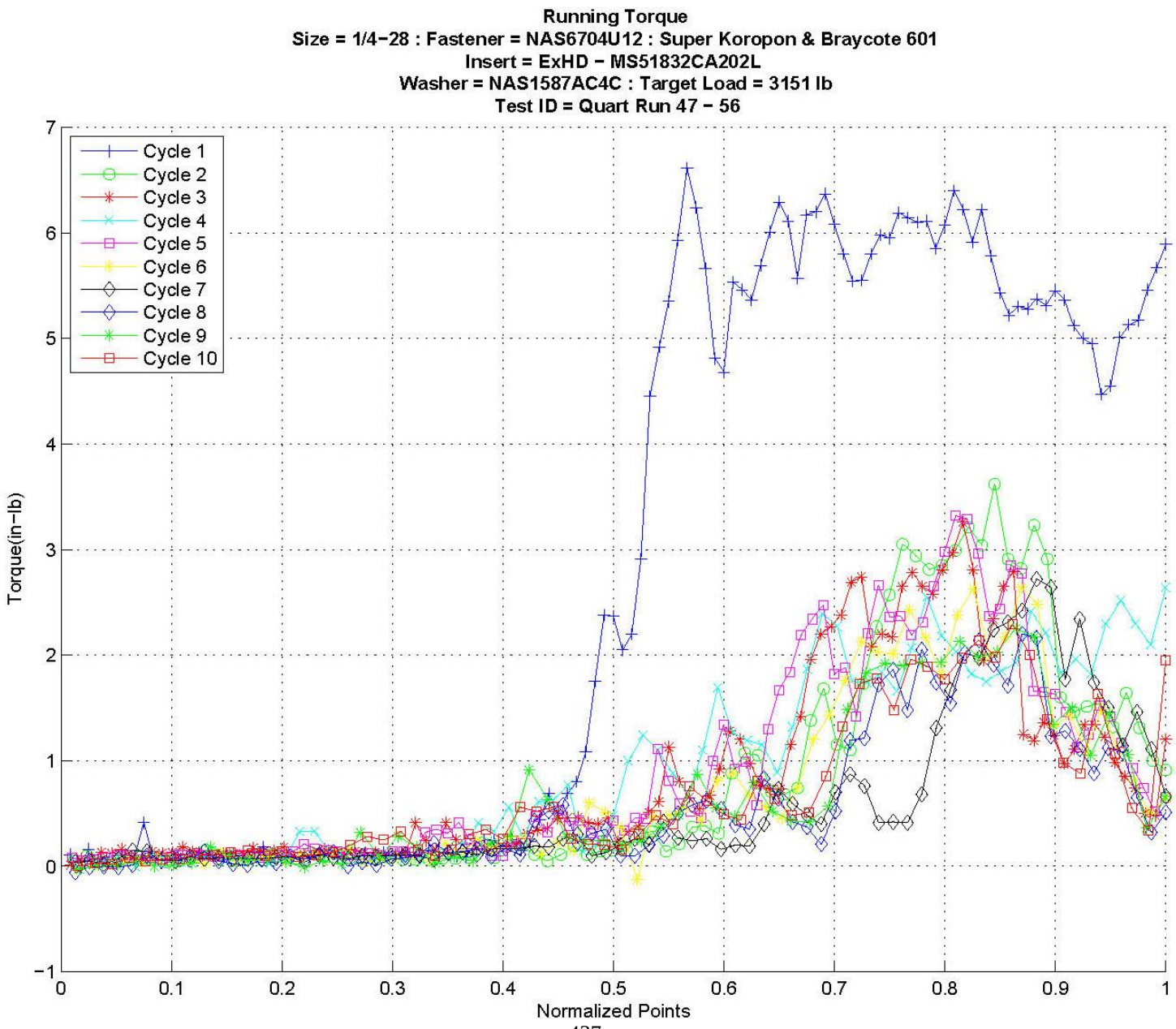

Running Torque
Size = 1/4−28 : Fastener = NAS6704U12 : Super Koropon & No Braycote
Insert = HD − MS51831CA202L
Washer = NAS1587AC4C : Target Load = 3151 lb
Test ID = Quart Run 67 − 76
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Cycle 7
Cycle 8
Cycle 9
Cycle 10
Torque(in−lb)
Normalized Points
25
20
15
10
5
0
−5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

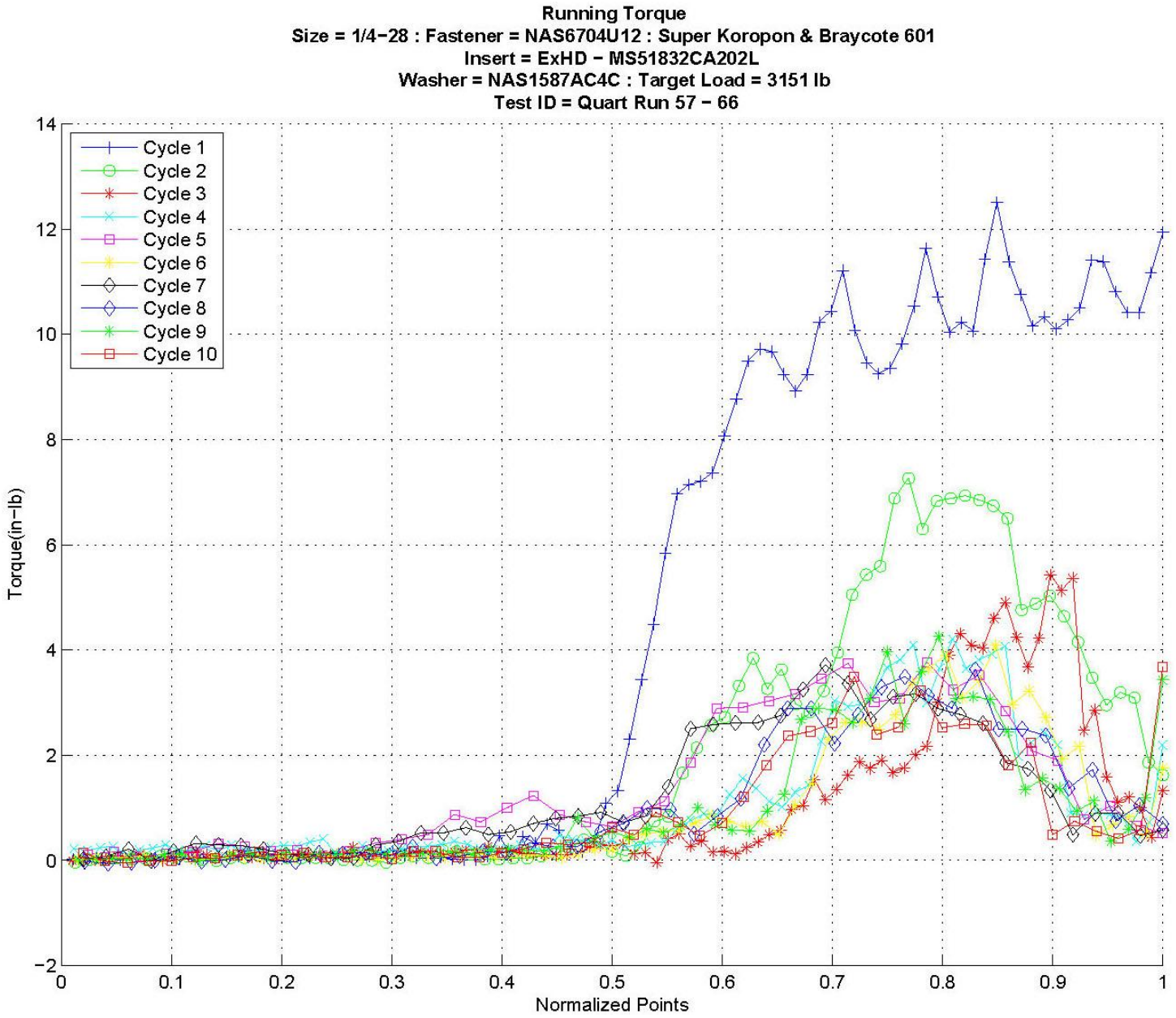

Running Torque
Size = 1/4-28 : Fastener = NAS6704U12 : Super Koropon & No Braycote
Insert = HD - MS51831CA202L
Washer = NAS1587AC4C : Target Load = 3151 lb
Test ID = Quart Run 77 - 86
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Cycle 7
Cycle 8
Cycle 9
Cycle 10
1st Bolt
2nd Bolt
Torque(in-lb)
Normalized Points
14
12
10
8
6
4
2
0
-2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

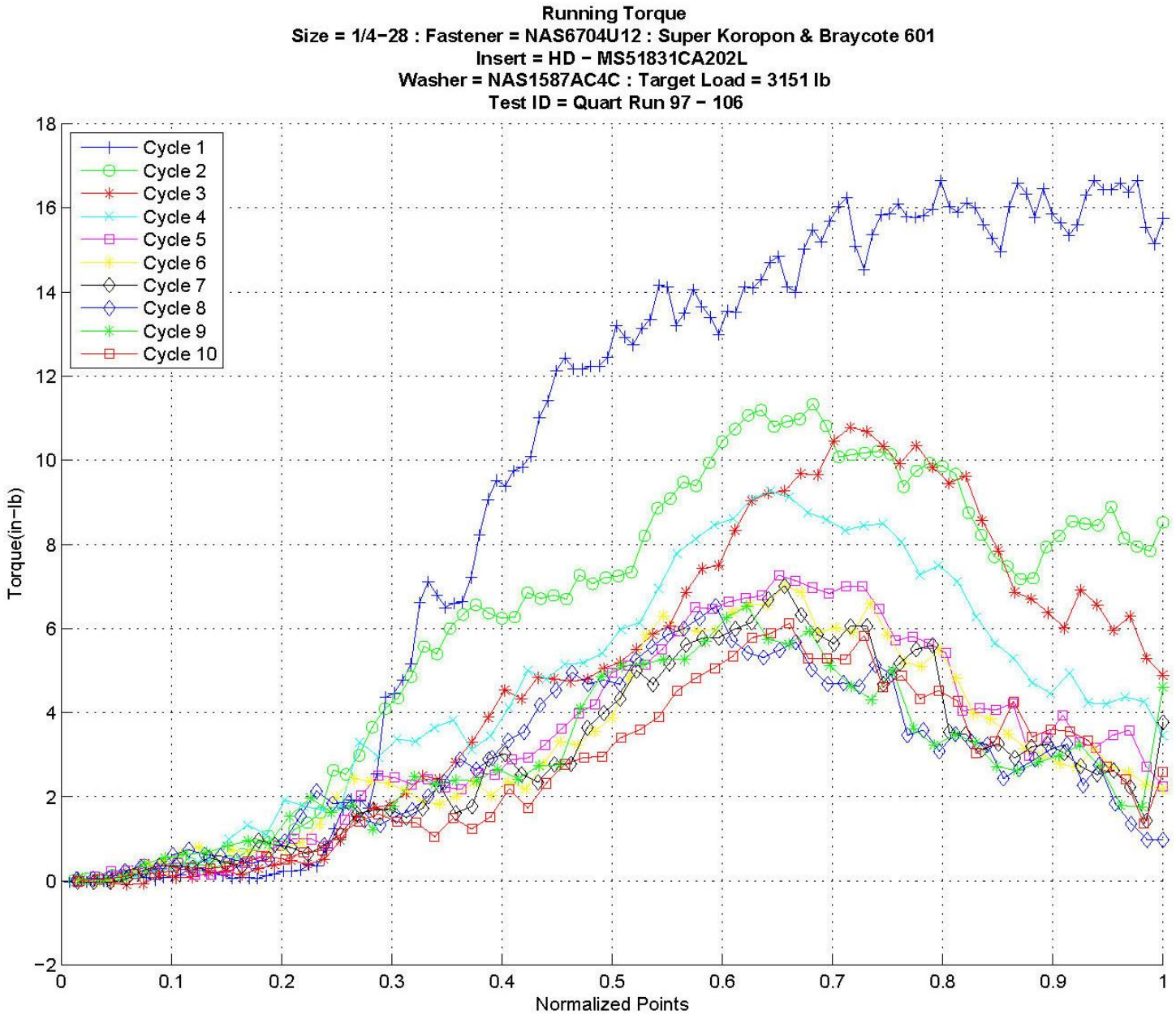

Running Torque
Size = 1/4-28 : Fastener = NAS6704U12 : Super Koropon & No Braycote
Insert = HD - MS51831CA202L
Washer = NAS1587AC4C : Target Load = 3151 lb
Test ID = Quart Run 87 - 96
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Cycle 7
Cycle 8
Cycle 9
Cycle 10
Torque(in-lb)
Normalized Points
18
16
14
12
10
8
6
4
2
0
-2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

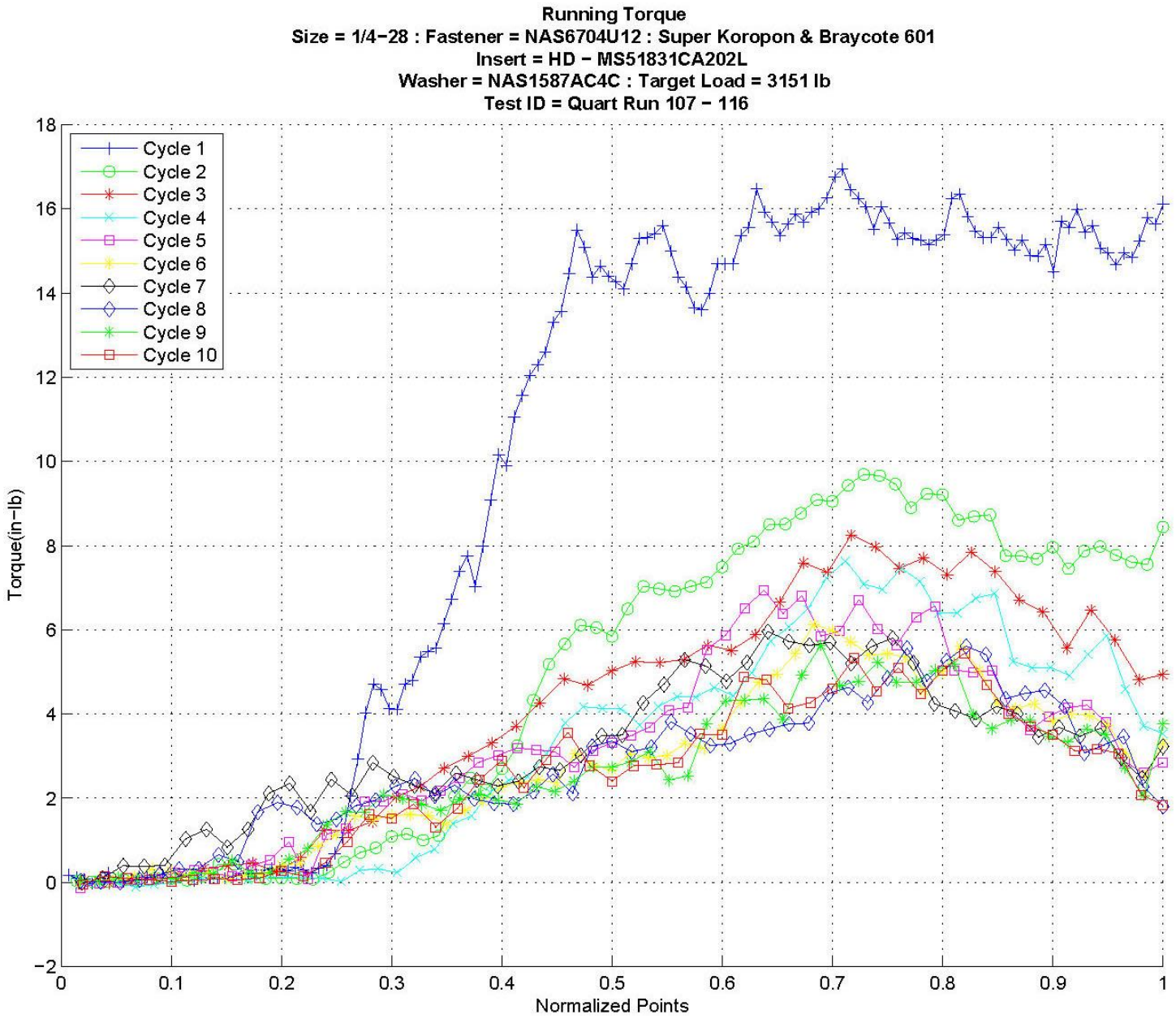
Appendix D:

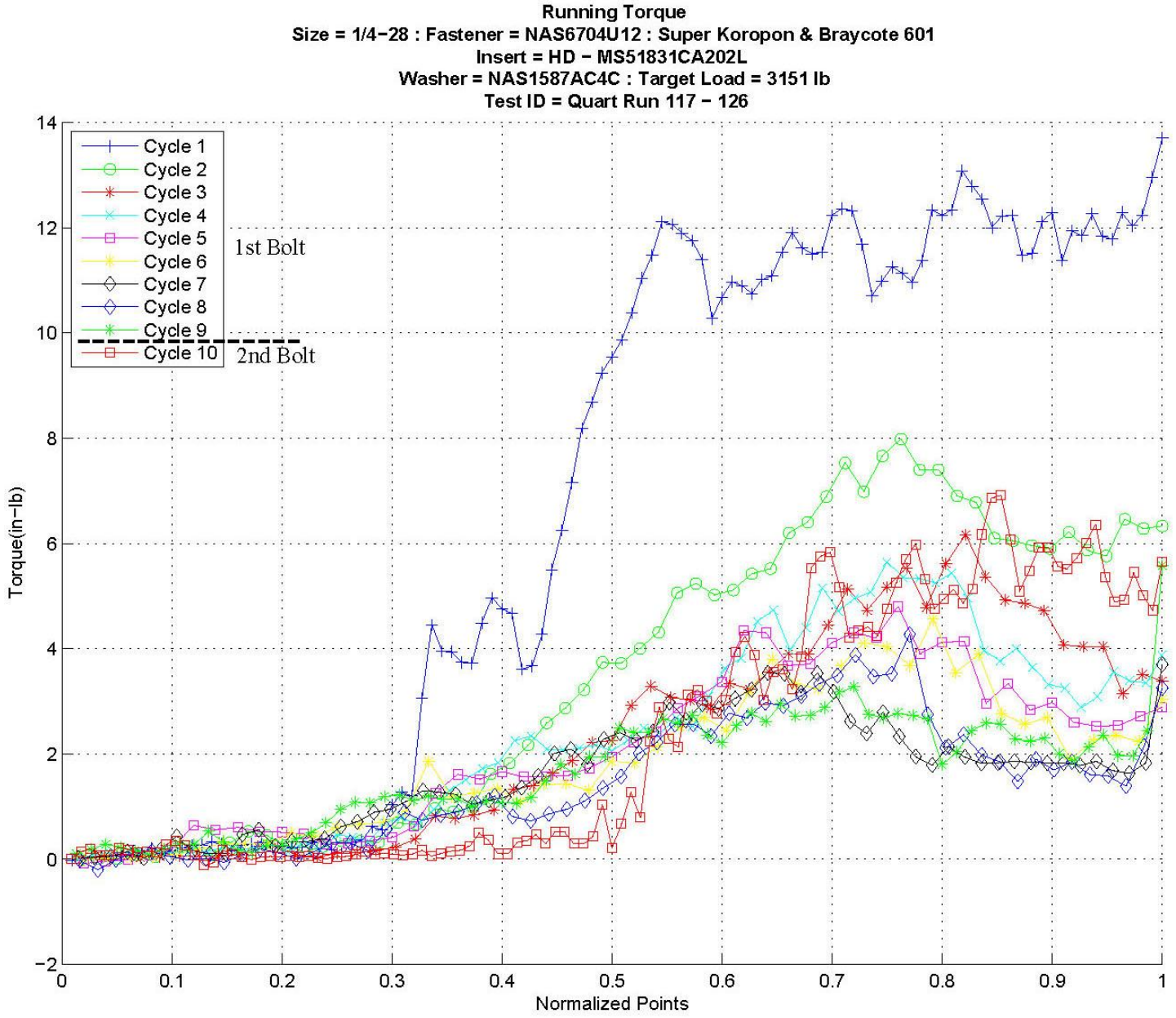
Section 1	1/4-28 No Braycote Torque Tension Plots
Section 2	1/4-28 Braycote 601 Torque Tension Plots
Section 3	1/4-28 Braycote 602 Torque Tension Plots
Section 4	1/4-28 No Braycote Running Torque Plots
Section 5	1/4-28 Braycote 601 Running Torque Plots
Section 6	1/4-28 Braycote 602 Running Torque Plots
Section 7	1/4-28 No Braycote Cycle Plots: Torque v. Load
Section 8	1/4-28 Braycote 601 Cycle Plots: Torque v. Load
Section 9	1/4-28 Braycote 602 Cycle Plots: Torque v. Load
Section 10	1/4-28 Friction Coefficients with Statistics
Section 11	1/4-28 Test Plate Layouts
Section 12	1/4-28 No Braycote Run Log
Section 13	1/4-28 Braycote 601 Run Logs
Section 14	1/4-28 Braycote 602 Run Logs


Running Torque
Size = 1/4-28 : Fastener = NAS6704U12 : Super Koropon & Braycote 601
Insert = ExHD - MS51832CA202L
Washer = NAS1587AC4C : Target Load = 3151 lb
Test ID = Quart Run 47 - 56
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Cycle 7
Cycle 8
Cycle 9
Cycle 10
Torque(in-lb)
Normalized Points
7
6
5
4
3
2
1
0
-1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


Running Torque
Size = 1/4-28 : Fastener = NAS6704U12 : Super Koropon & Braycote 601
Insert = ExHD - MS51832CA202L
Washer = NAS1587AC4C : Target Load = 3151 lb
Test ID = Quart Run 57 - 66
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Cycle 7
Cycle 8
Cycle 9
Cycle 10
Torque(in-lb)
Normalized Points
14
12
10
8
6
4
2
0
-2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

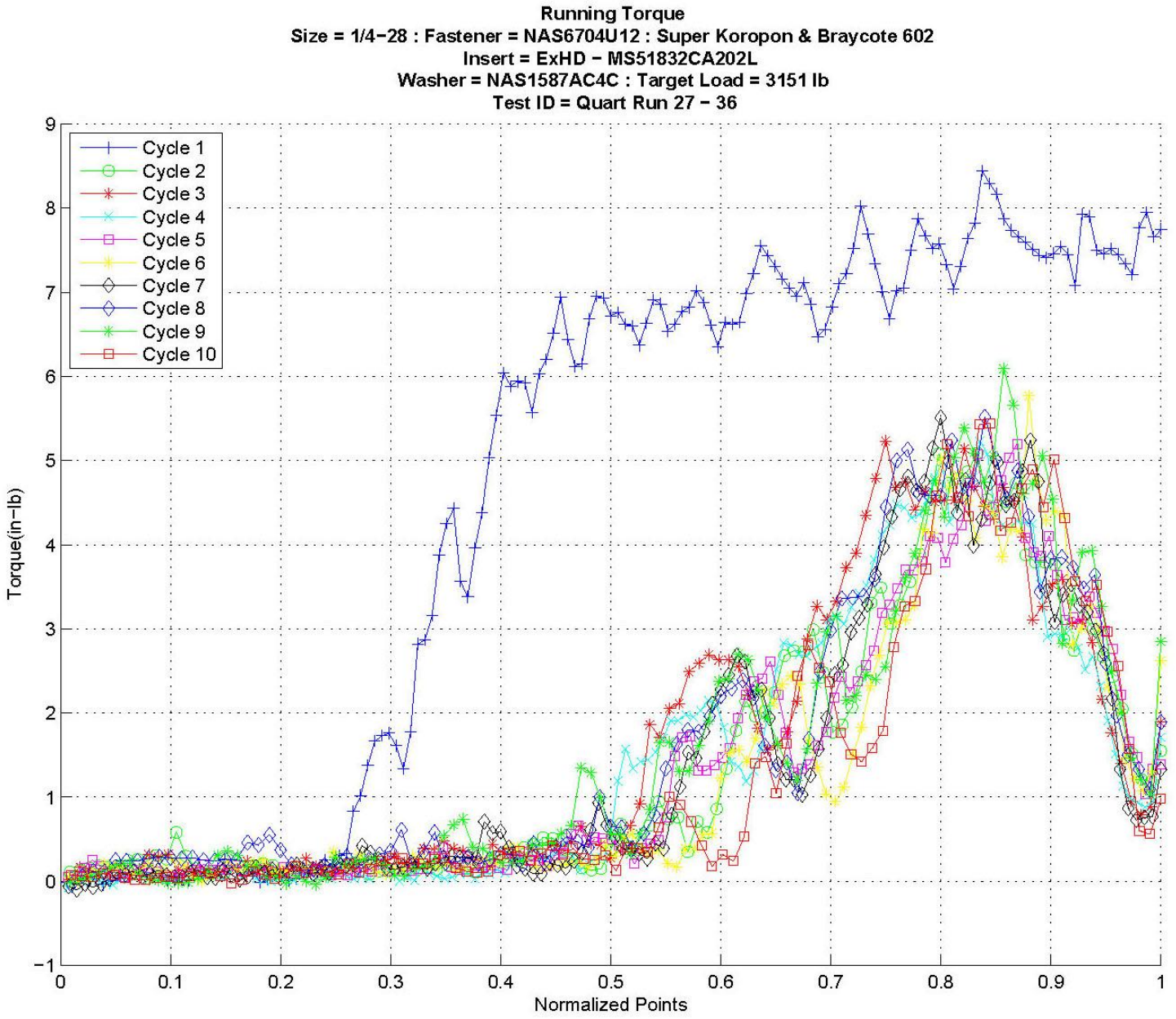

Running Torque
Size = 1/4-28 : Fastener = NAS6704U12 : Super Koropon & Braycote 601
Insert = HD - MS51831CA202L
Washer = NAS1587AC4C : Target Load = 3151 lb
Test ID = Quart Run 97 - 106
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Cycle 7
Cycle 8
Cycle 9
Cycle 10
Torque(in-lb)
Normalized Points
18
16
14
12
10
8
6
4
2
0
-2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

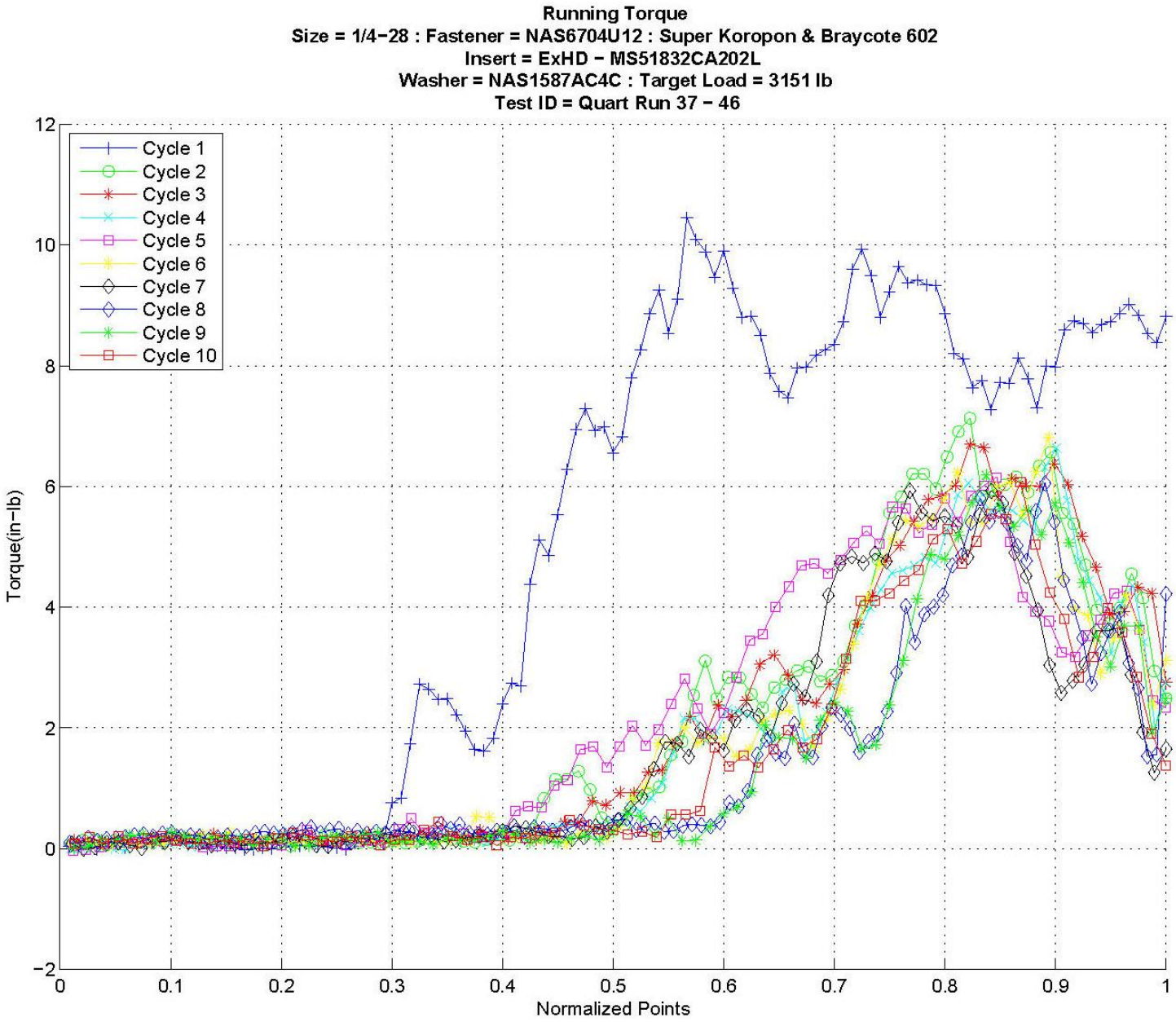

Running Torque
Size = 1/4-28 : Fastener = NAS6704U12 : Super Koropon & Braycote 601
Insert = HD - MS51831CA202L
Washer = NAS1587AC4C : Target Load = 3151 lb
Test ID = Quart Run 107 - 116
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Cycle 7
Cycle 8
Cycle 9
Cycle 10
Torque(in-lb)
Normalized Points
18
16
14
12
10
8
6
4
2
0
-2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

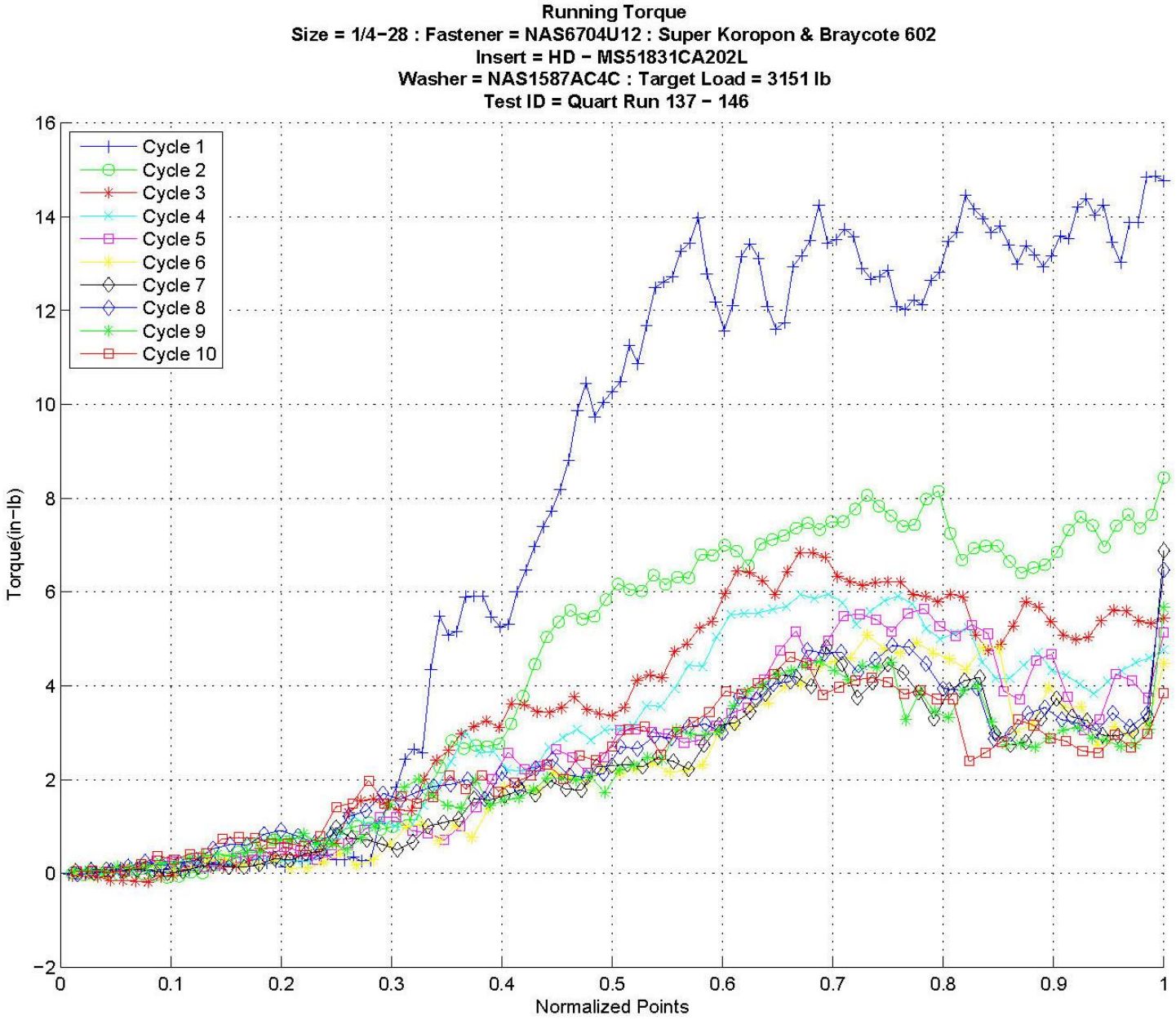

Running Torque
Size = 1/4-28 : Fastener = NAS6704U12 : Super Koropon & Braycote 601
Insert = HD - MS51831CA202L
Washer = NAS1587AC4C : Target Load = 3151 lb
Test ID = Quart Run 117 - 126
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Cycle 7
Cycle 8
Cycle 9
Cycle 10
1st Bolt
2nd Bolt
Torque(in-lb)
Normalized Points
14
12
10
8
6
4
2
0
-2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

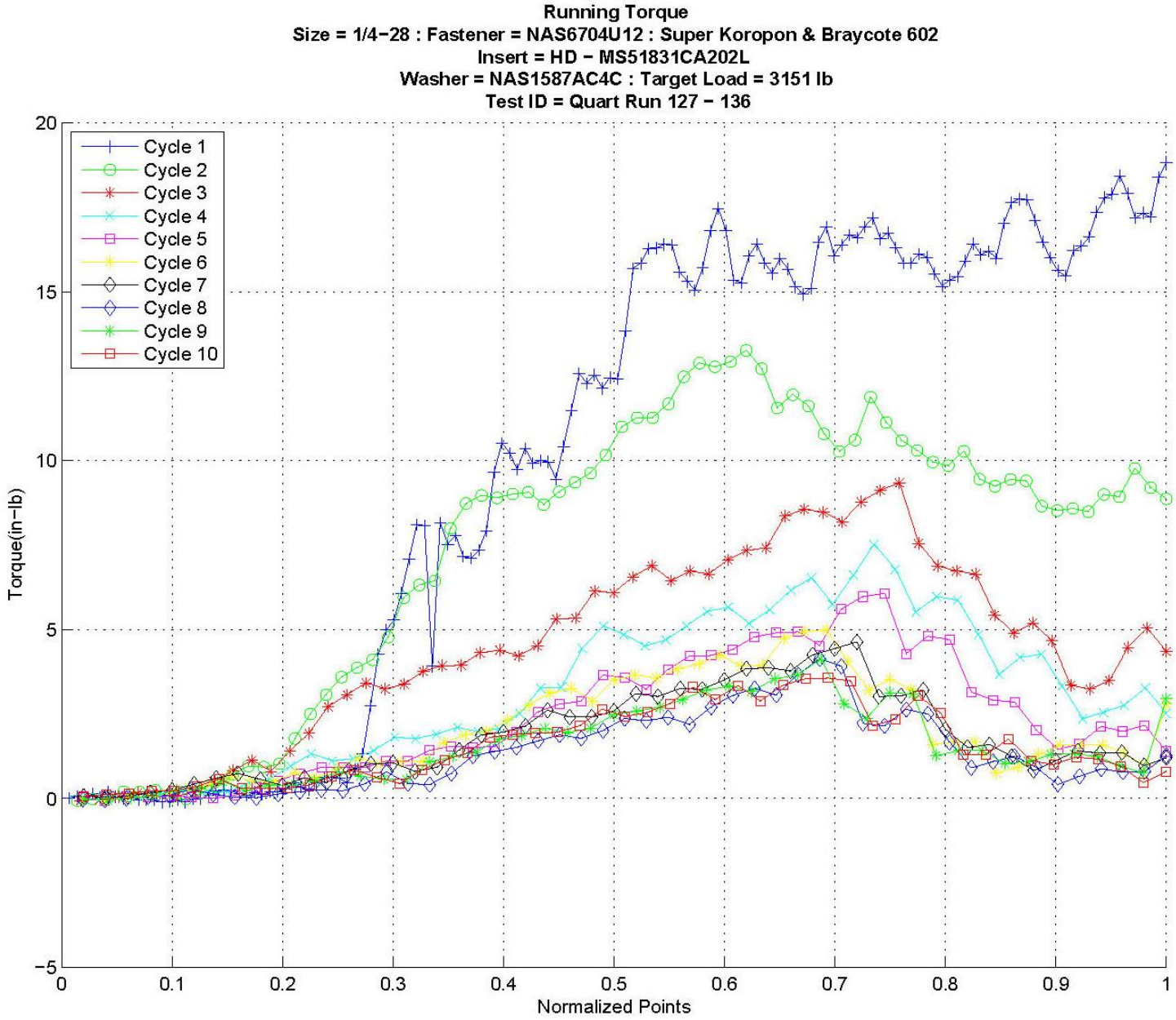
Appendix D:

Section 1	1/4-28 No Braycote Torque Tension Plots
Section 2	1/4-28 Braycote 601 Torque Tension Plots
Section 3	1/4-28 Braycote 602 Torque Tension Plots
Section 4	1/4-28 No Braycote Running Torque Plots
Section 5	1/4-28 Braycote 601 Running Torque Plots
Section 6	1/4-28 Braycote 602 Running Torque Plots
Section 7	1/4-28 No Braycote Cycle Plots: Torque v. Load
Section 8	1/4-28 Braycote 601 Cycle Plots: Torque v. Load
Section 9	1/4-28 Braycote 602 Cycle Plots: Torque v. Load
Section 10	1/4-28 Friction Coefficients with Statistics
Section 11	1/4-28 Test Plate Layouts
Section 12	1/4-28 No Braycote Run Log
Section 13	1/4-28 Braycote 601 Run Logs
Section 14	1/4-28 Braycote 602 Run Logs


Running Torque
Size = 1/4-28 : Fastener = NAS6704U12 : Super Koropon & Braycote 602
Insert = ExHD - MS51832CA202L
Washer = NAS1587AC4C : Target Load = 3151 lb
Test ID = Quart Run 27 - 36
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Cycle 7
Cycle 8
Cycle 9
Cycle 10
Torque(in-lb)
Normalized Points
9
8
7
6
5
4
3
2
1
0
-1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

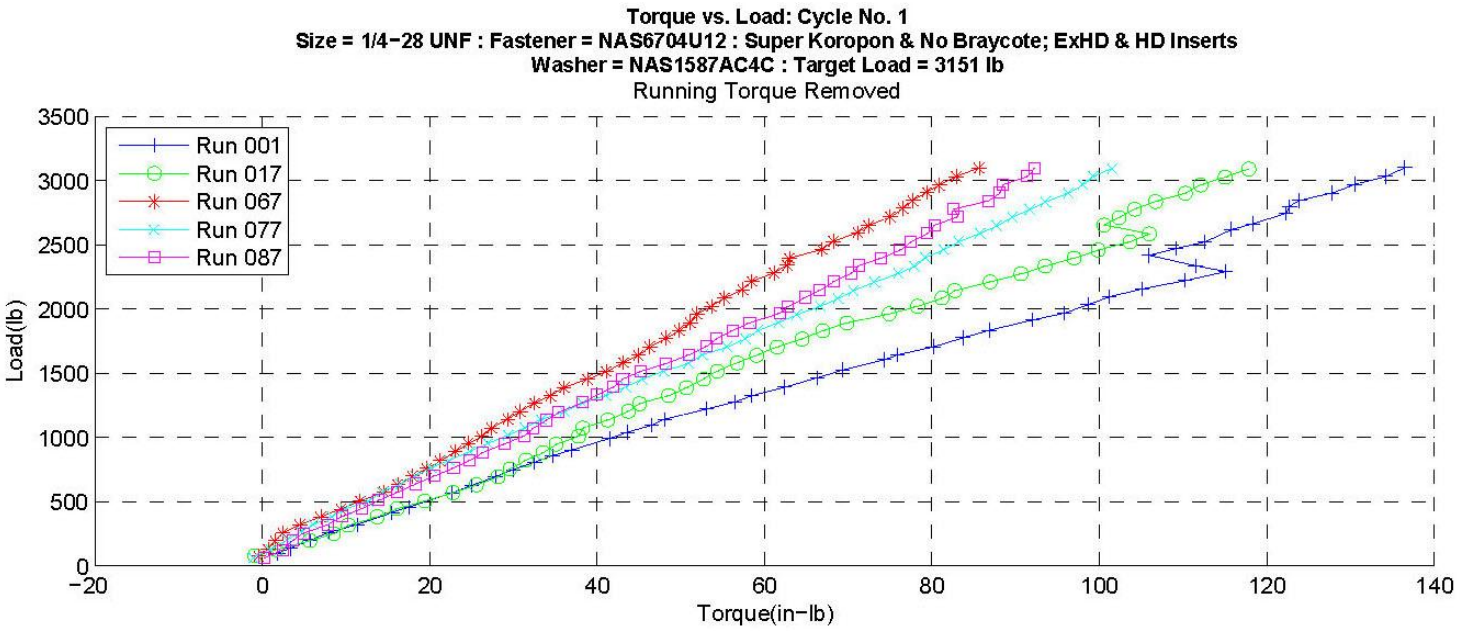

Running Torque
Size = 1/4-28 : Fastener = NAS6704U12 : Super Koropon & Braycote 602
Insert = ExHD - MS51832CA202L
Washer = NAS1587AC4C : Target Load = 3151 lb
Test ID = Quart Run 37 - 46
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Cycle 7
Cycle 8
Cycle 9
Cycle 10
Torque(in-lb)
Normalized Points
12
10
8
6
4
2
0
-2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

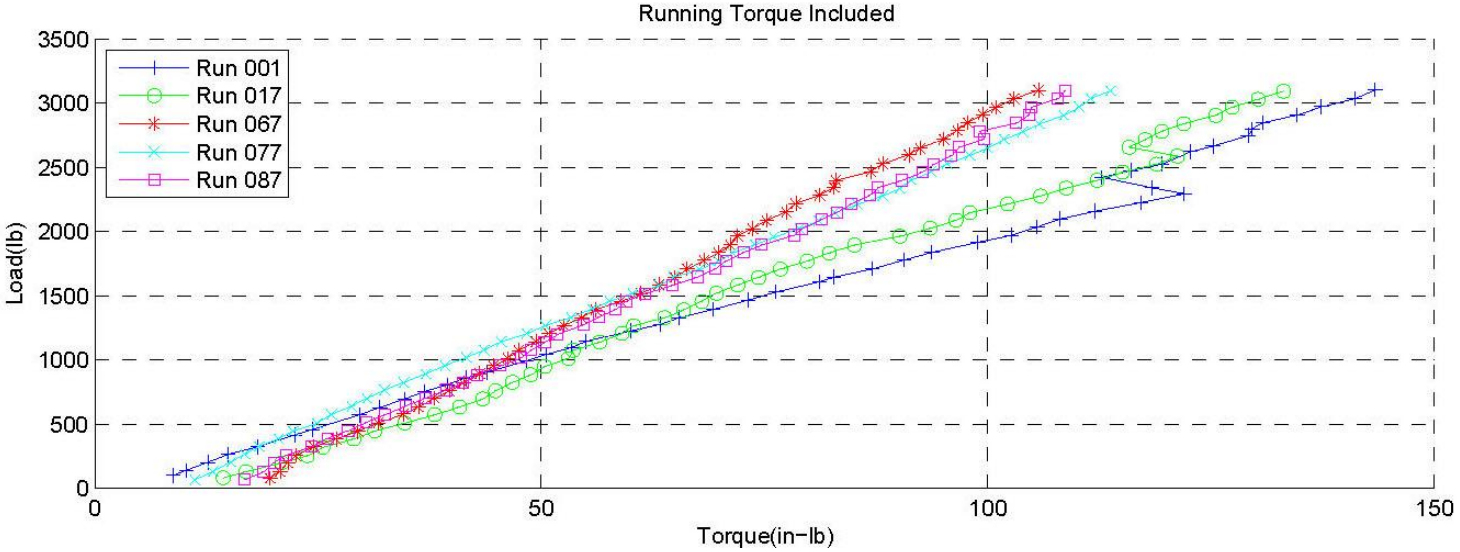

Running Torque
Size = 1/4-28 : Fastener = NAS6704U12 : Super Koropon & Braycote 602
Insert = HD - MS51831CA202L
Washer = NAS1587AC4C : Target Load = 3151 lb
Test ID = Quart Run 137 - 146
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Cycle 7
Cycle 8
Cycle 9
Cycle 10
Torque(in-lb)
Normalized Points
16
14
12
10
8
6
4
2
0
-2
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

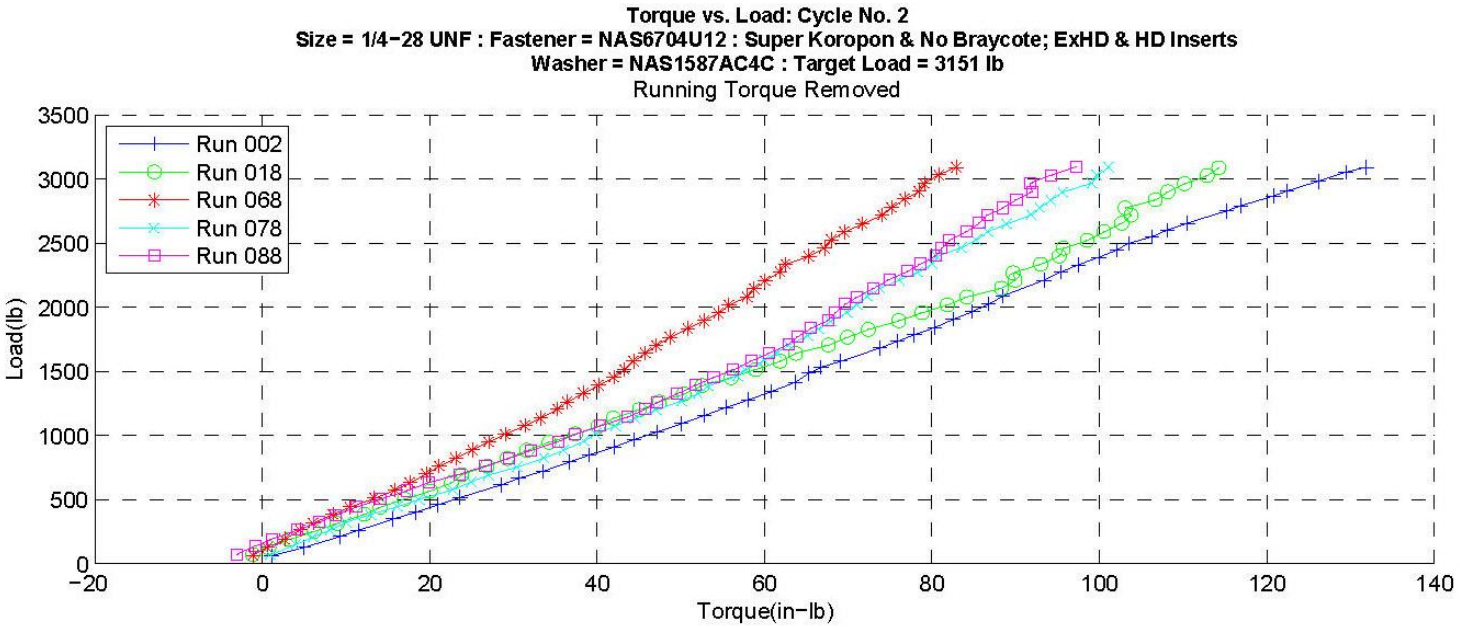

Running Torque
Size = 1/4-28 : Fastener = NAS6704U12 : Super Koropon & Braycote 602
Insert = HD - MS51831CA202L
Washer = NAS1587AC4C : Target Load = 3151 lb
Test ID = Quart Run 127 - 136
Cycle 1
Cycle 2
Cycle 3
Cycle 4
Cycle 5
Cycle 6
Cycle 7
Cycle 8
Cycle 9
Cycle 10
Torque(in-lb)
Normalized Points
20
15
10
5
0
-5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

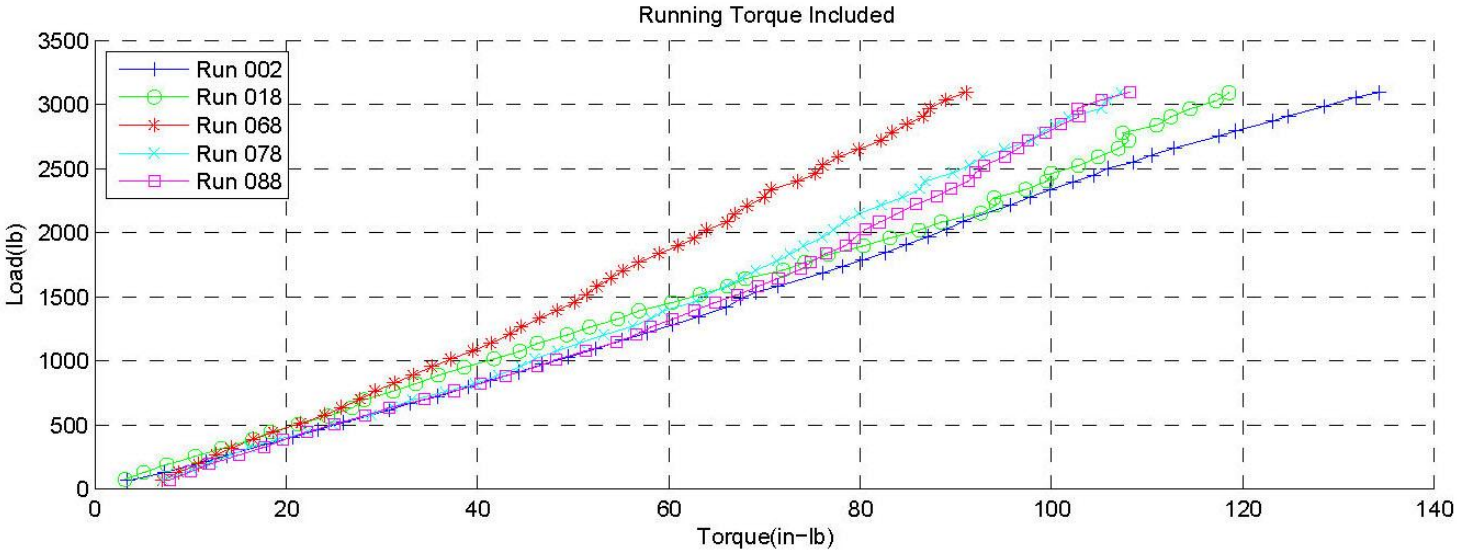
Appendix D:

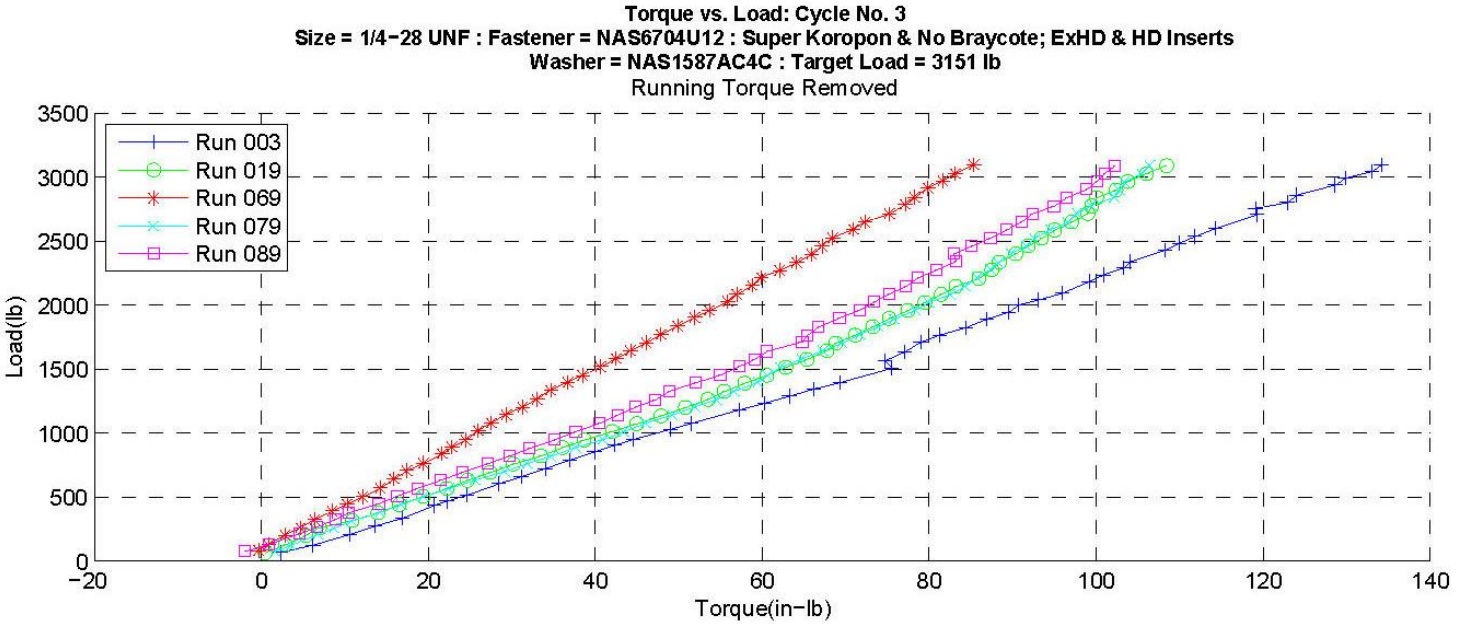
Section 1	1/4-28 No Braycote Torque Tension Plots
Section 2	1/4-28 Braycote 601 Torque Tension Plots
Section 3	1/4-28 Braycote 602 Torque Tension Plots
Section 4	1/4-28 No Braycote Running Torque Plots
Section 5	1/4-28 Braycote 601 Running Torque Plots
Section 6	1/4-28 Braycote 602 Running Torque Plots
Section 7	1/4-28 No Braycote Cycle Plots: Torque v. Load
Section 8	1/4-28 Braycote 601 Cycle Plots: Torque v. Load
Section 9	1/4-28 Braycote 602 Cycle Plots: Torque v. Load
Section 10	1/4-28 Friction Coefficients with Statistics
Section 11	1/4-28 Test Plate Layouts
Section 12	1/4-28 No Braycote Run Log
Section 13	1/4-28 Braycote 601 Run Logs
Section 14	1/4-28 Braycote 602 Run Logs

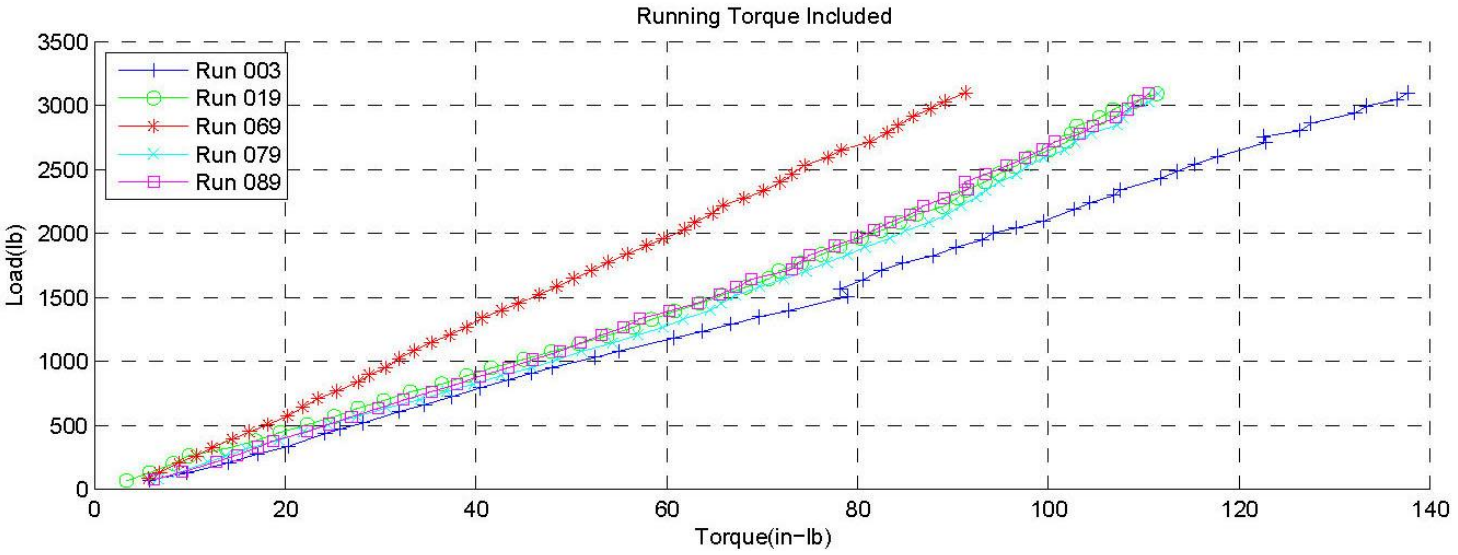

Torque vs. Load: Cycle No. 1
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & No Braycote; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 001
Run 017
Run 067
Run 077
Run 087
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
-20
0
20
40
60
80
100
120
140

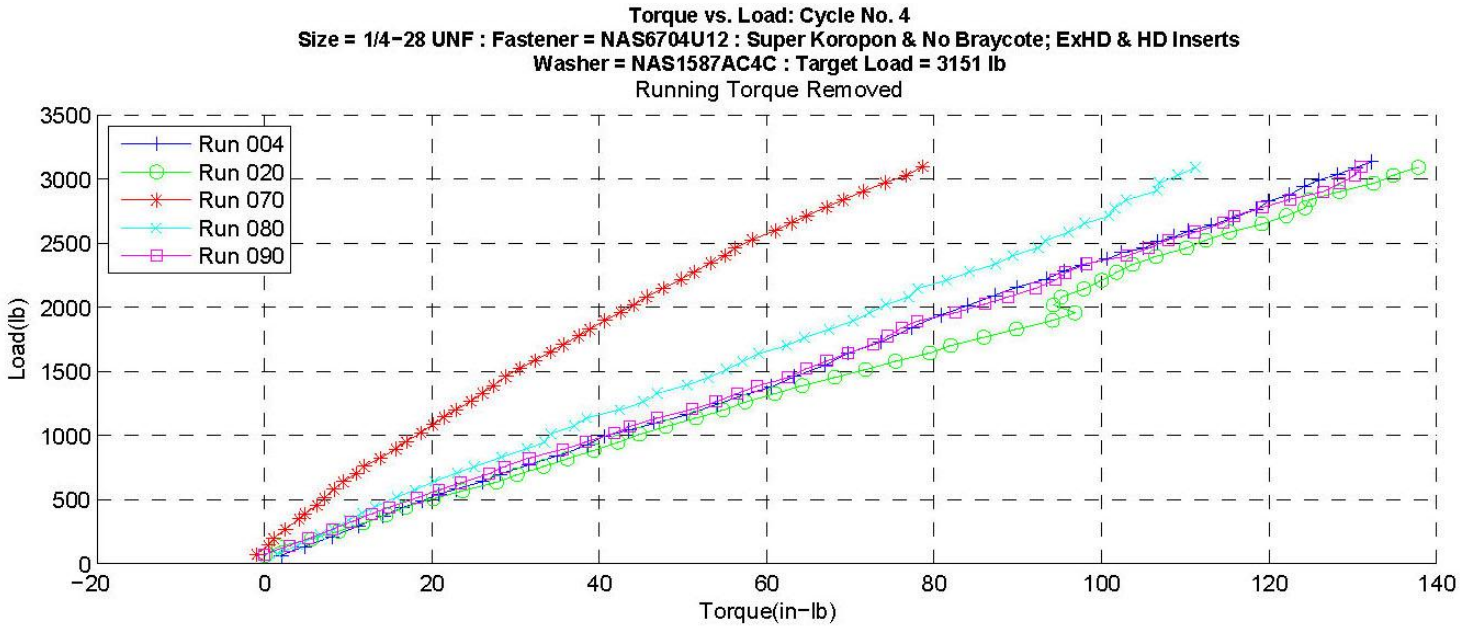

Running Torque Included
Run 001
Run 017
Run 067
Run 077
Run 087
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
0
50
100
150

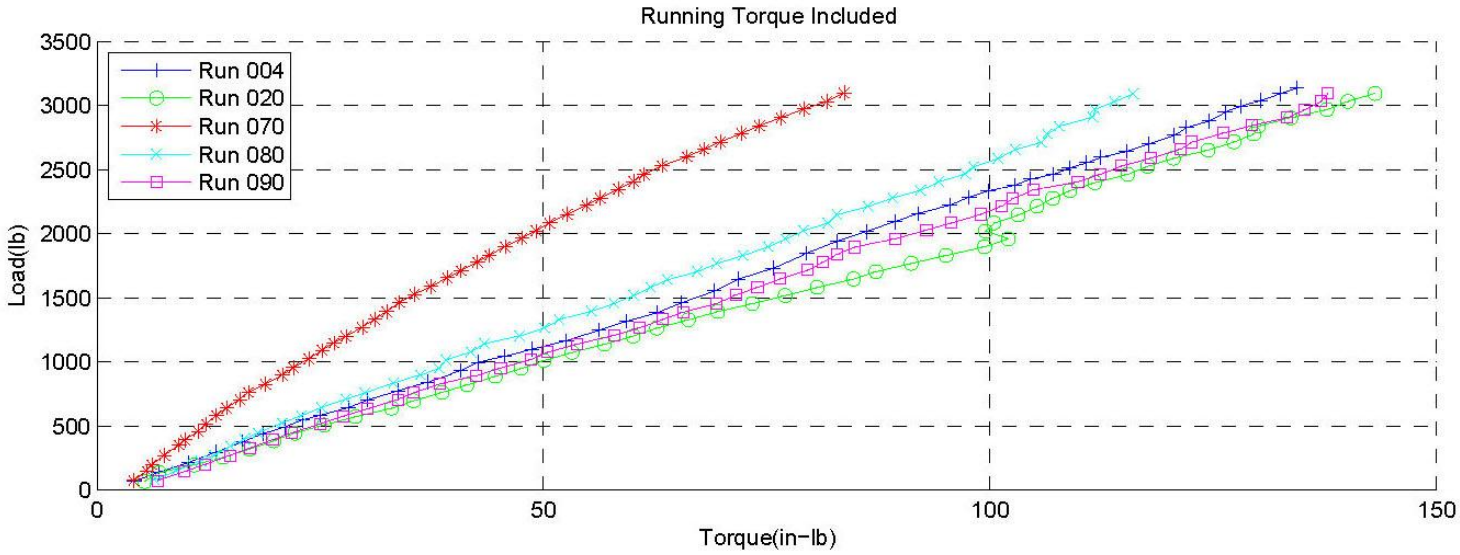

Torque vs. Load: Cycle No. 2
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & No Braycote; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 002
Run 018
Run 068
Run 078
Run 088
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
-20
0
20
40
60
80
100
120
140

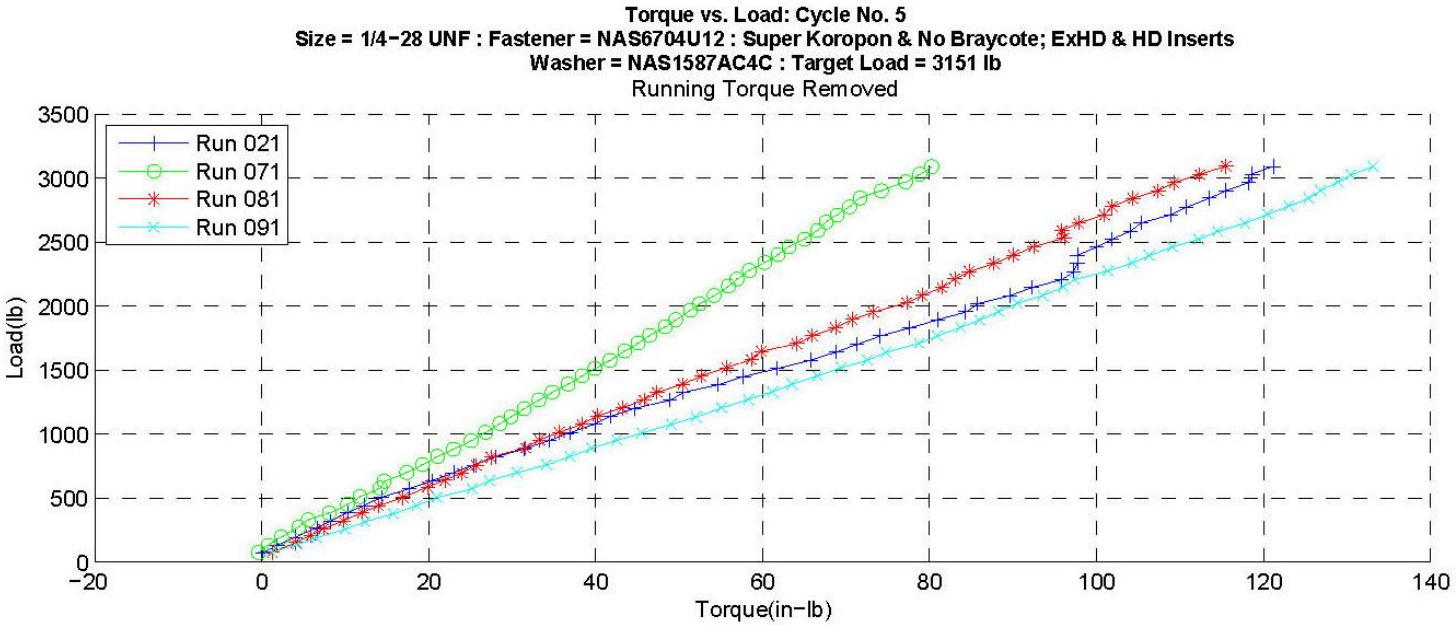

Running Torque Included
Run 002
Run 018
Run 068
Run 078
Run 088
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
120
140

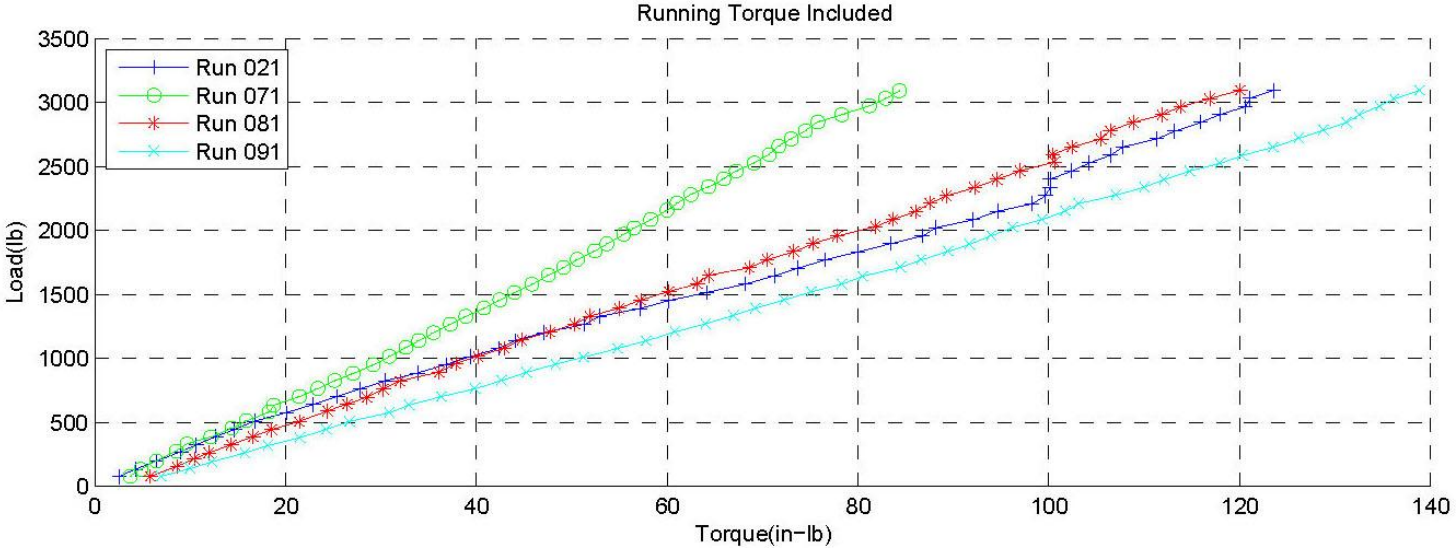

Torque vs. Load: Cycle No. 3
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & No Braycote; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 003
Run 019
Run 069
Run 079
Run 089
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
-20
0
20
40
60
80
100
120
140

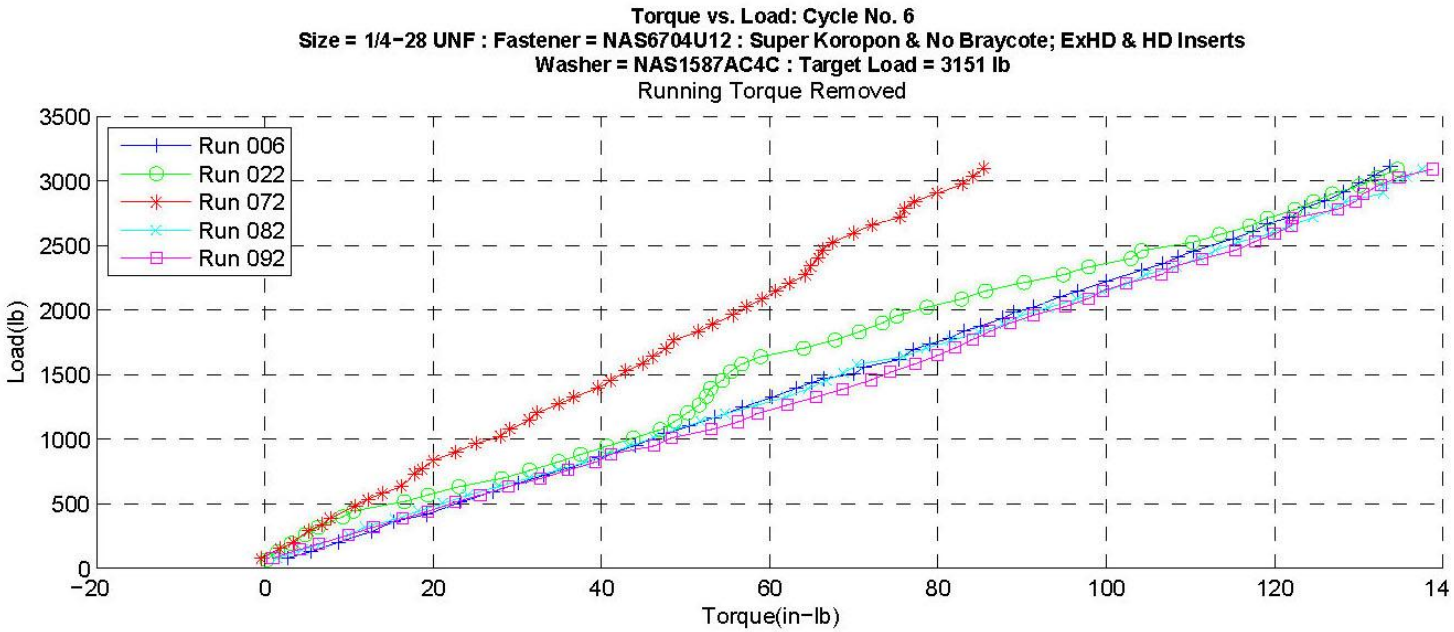

Running Torque Included
Run 003
Run 019
Run 069
Run 079
Run 089
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
120
140

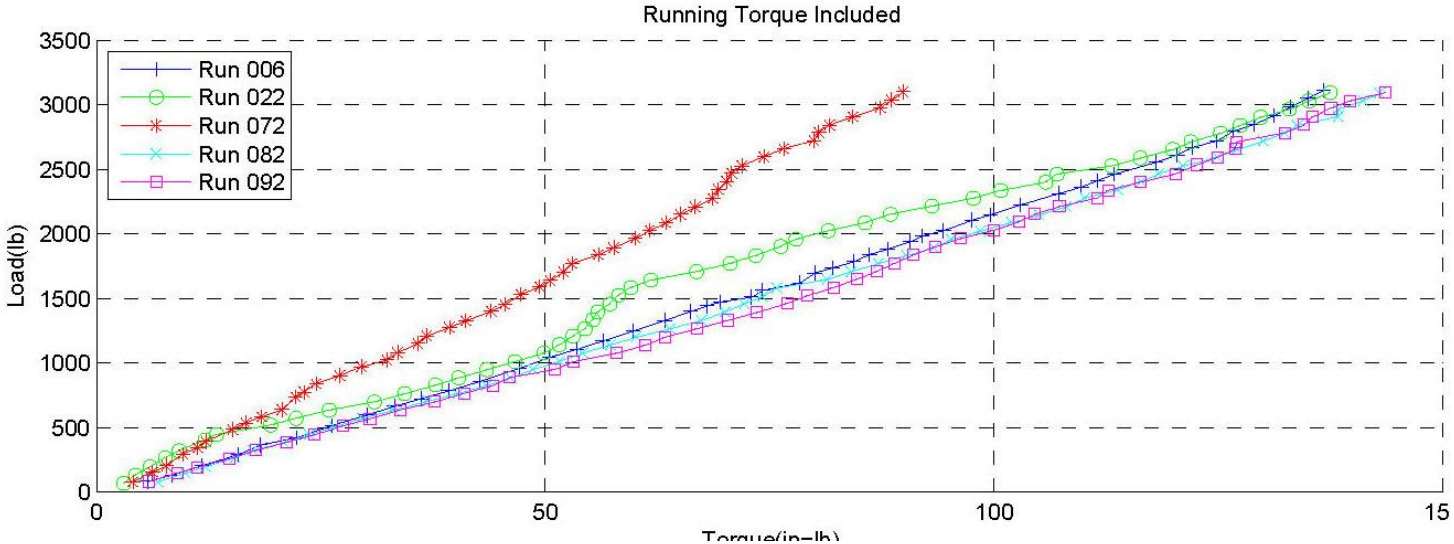

Torque vs. Load: Cycle No. 4
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & No Braycote; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 004
Run 020
Run 070
Run 080
Run 090
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
-20
0
20
40
60
80
100
120
140

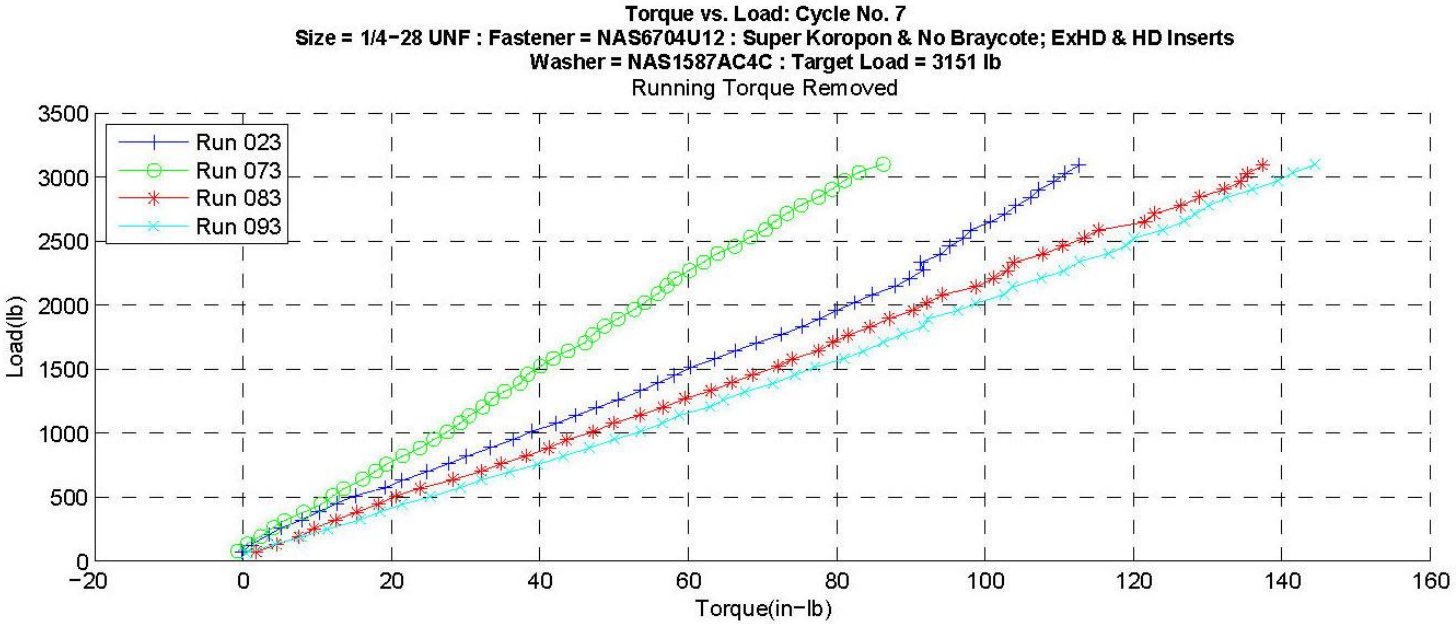

Running Torque Included
Run 004
Run 020
Run 070
Run 080
Run 090
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
0
50
100
150

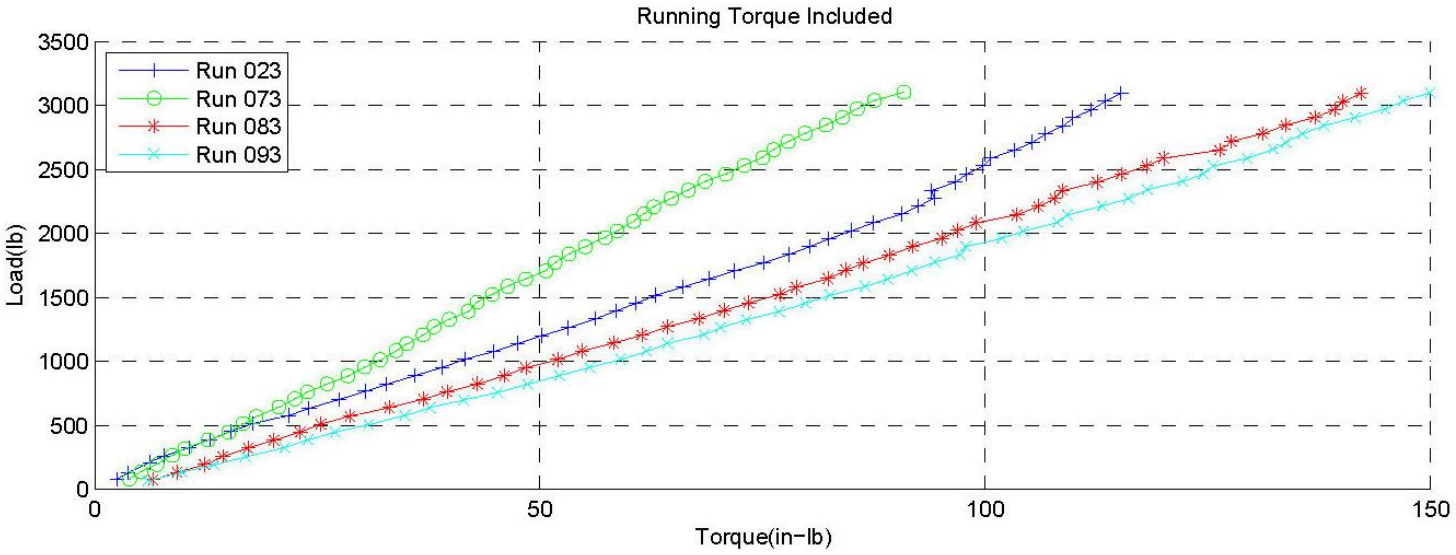

Torque vs. Load: Cycle No. 5
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & No Braycote; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 021
Run 071
Run 081
Run 091
Load(lb)
Torque(in-lb)
0
500
1000
1500
2000
2500
3000
3500
-20
0
20
40
60
80
100
120
140

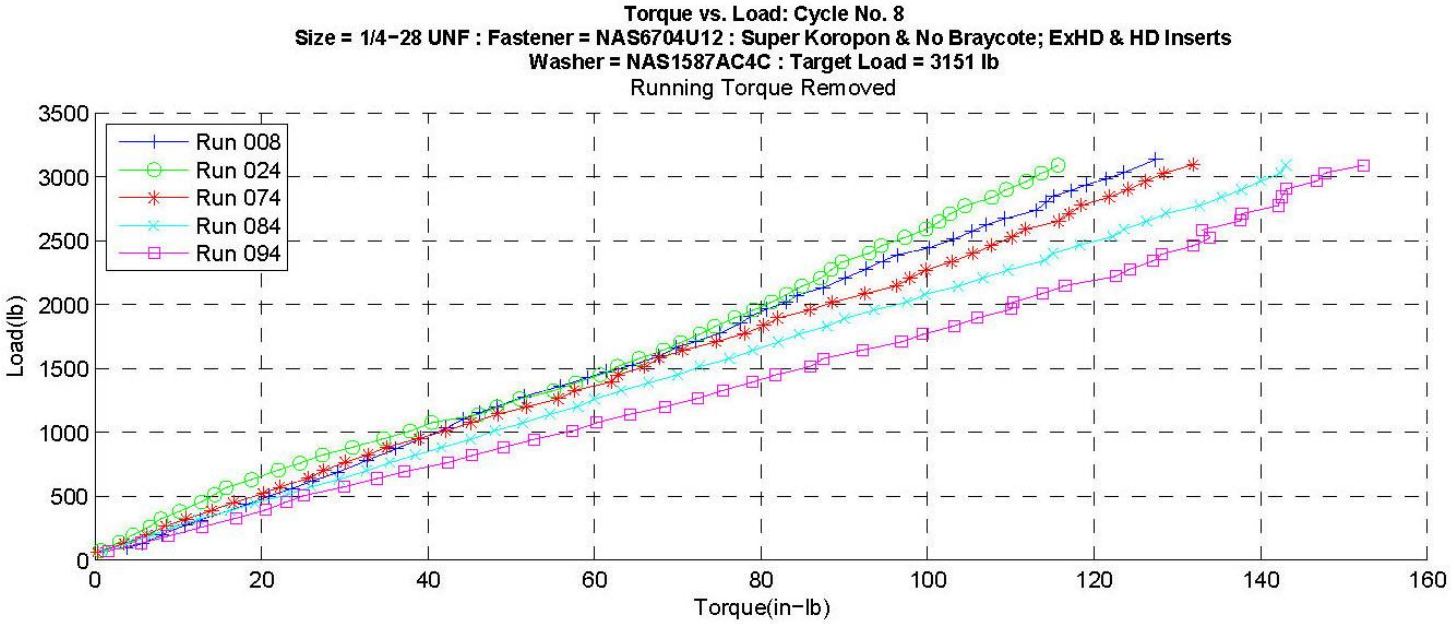

Running Torque Included
Run 021
Run 071
Run 081
Run 091
Load(lb)
Torque(in-lb)
0
500
1000
1500
2000
2500
3000
3500
0
20
40
60
80
100
120
140

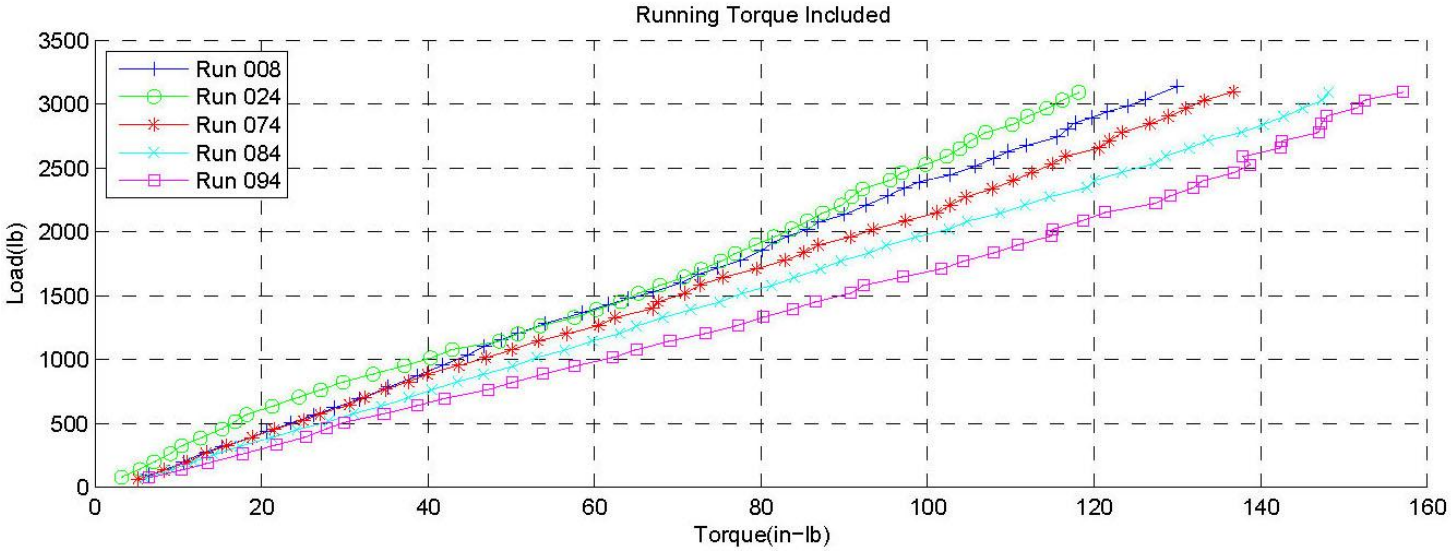

Torque vs. Load: Cycle No. 6
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & No Braycote; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 006
Run 022
Run 072
Run 082
Run 092
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
-20
0
20
40
60
80
100
120
14

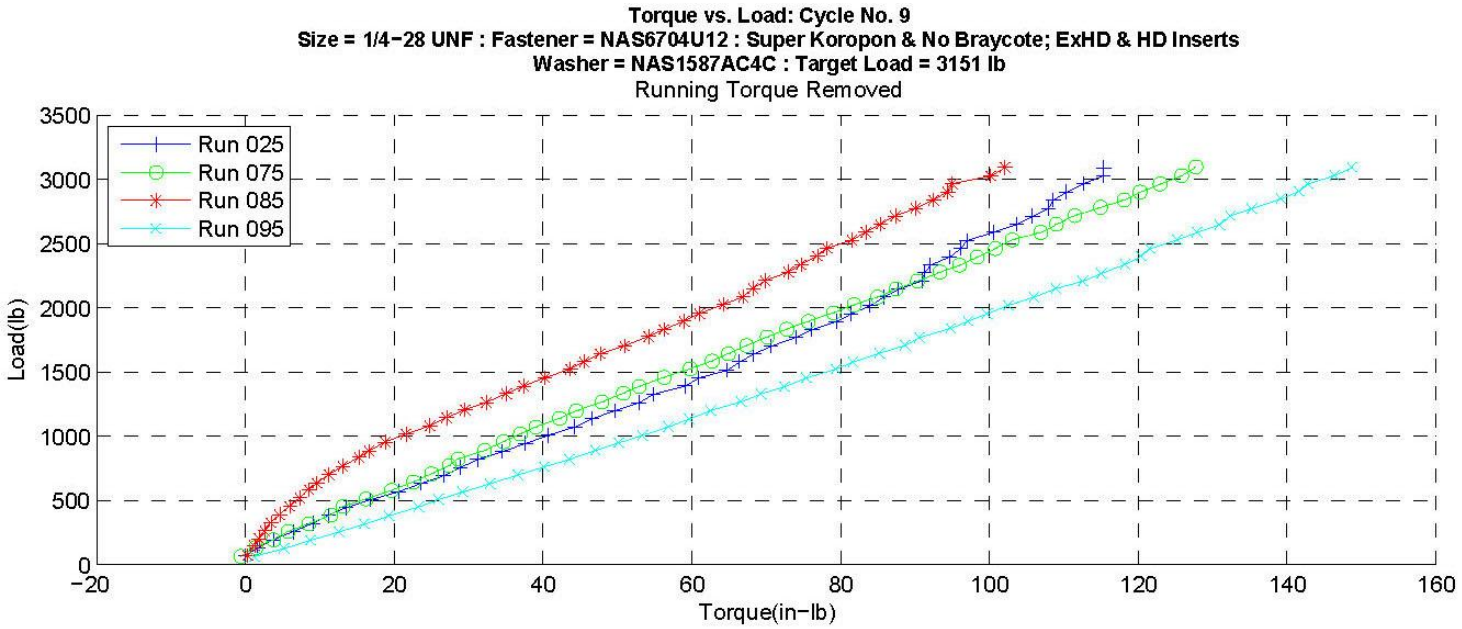

Running Torque Included
Run 006
Run 022
Run 072
Run 082
Run 092
Load(lb)
3500
3000
2500
2000
1500
1000
500
0
0
50
100
15

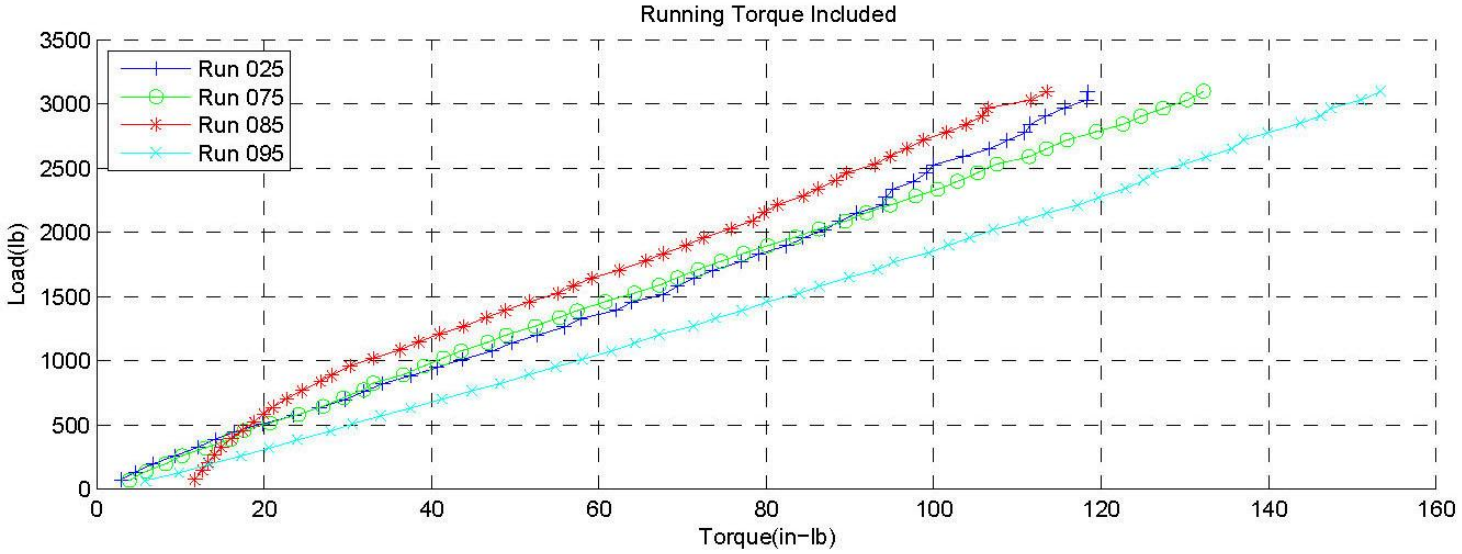

Torque vs. Load: Cycle No. 7
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & No Braycote; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 023
Run 073
Run 083
Run 093
Load(lb)
Torque(in-lb)
0
500
1000
1500
2000
2500
3000
3500
-20
0
20
40
60
80
100
120
140
160

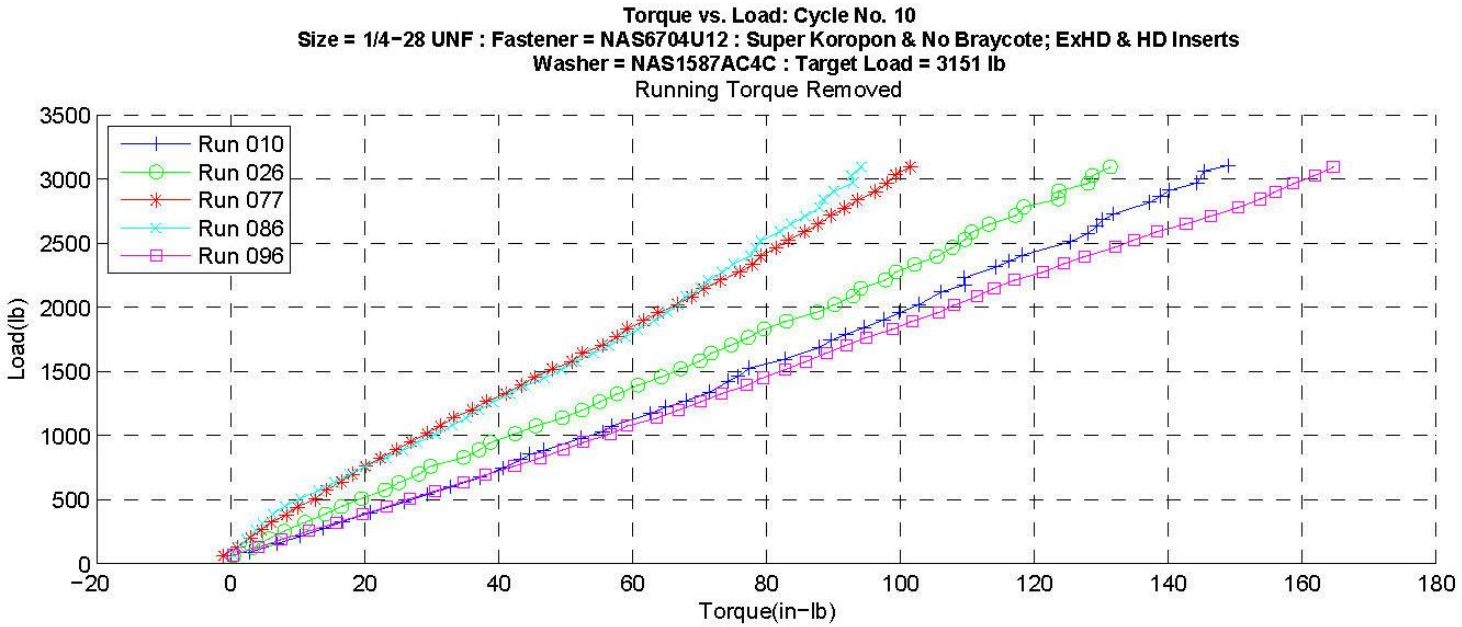

Running Torque Included
Run 023
Run 073
Run 083
Run 093
Load(lb)
Torque(in-lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150

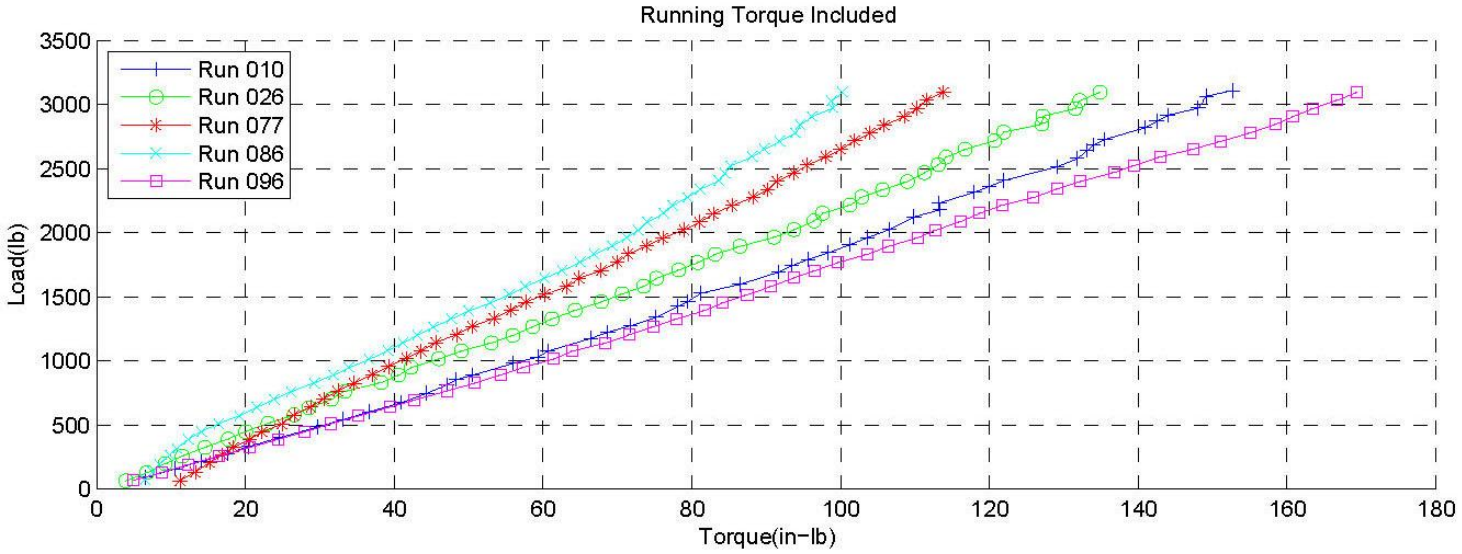

Torque vs. Load: Cycle No. 8
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & No Braycote; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 008
Run 024
Run 074
Run 084
Run 094
Load(lb)
Torque(in-lb)
0
500
1000
1500
2000
2500
3000
3500
0
20
40
60
80
100
120
140
160


Running Torque Included
Run 008
Run 024
Run 074
Run 084
Run 094
Load(lb)
Torque(in-lb)
0
500
1000
1500
2000
2500
3000
3500
0
20
40
60
80
100
120
140
160


Torque vs. Load: Cycle No. 9
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & No Braycote; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 025
Run 075
Run 085
Run 095
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
-20
0
20
40
60
80
100
120
140
160

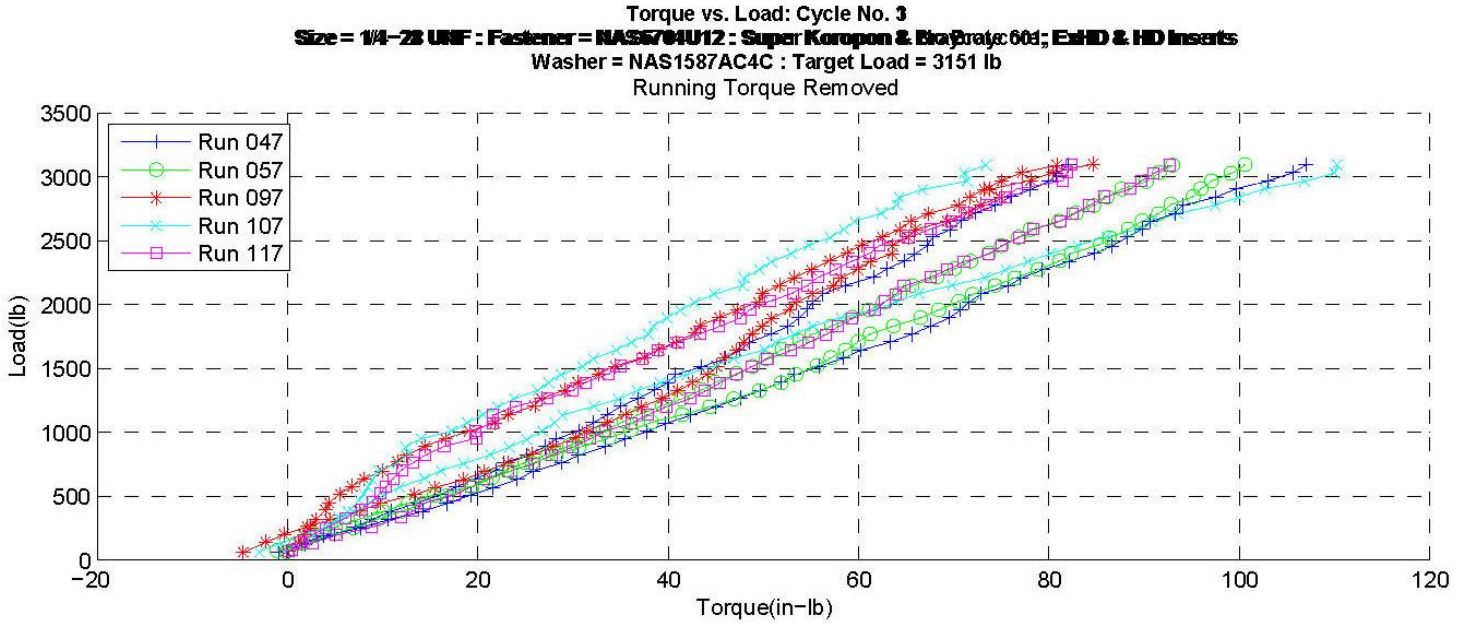

Running Torque Included
Run 025
Run 075
Run 085
Run 095
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
120
140
160

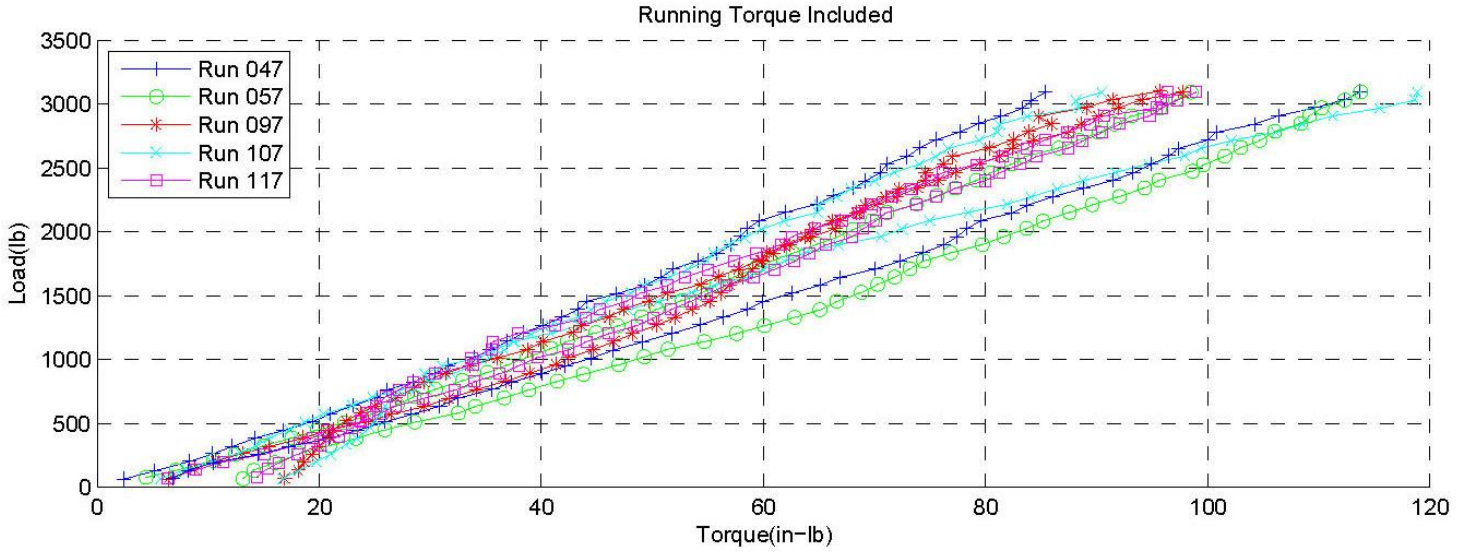

Torque vs. Load: Cycle No. 10
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & No Braycote; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 010
Run 026
Run 077
Run 086
Run 096
Load(lb)
Torque(in-lb)

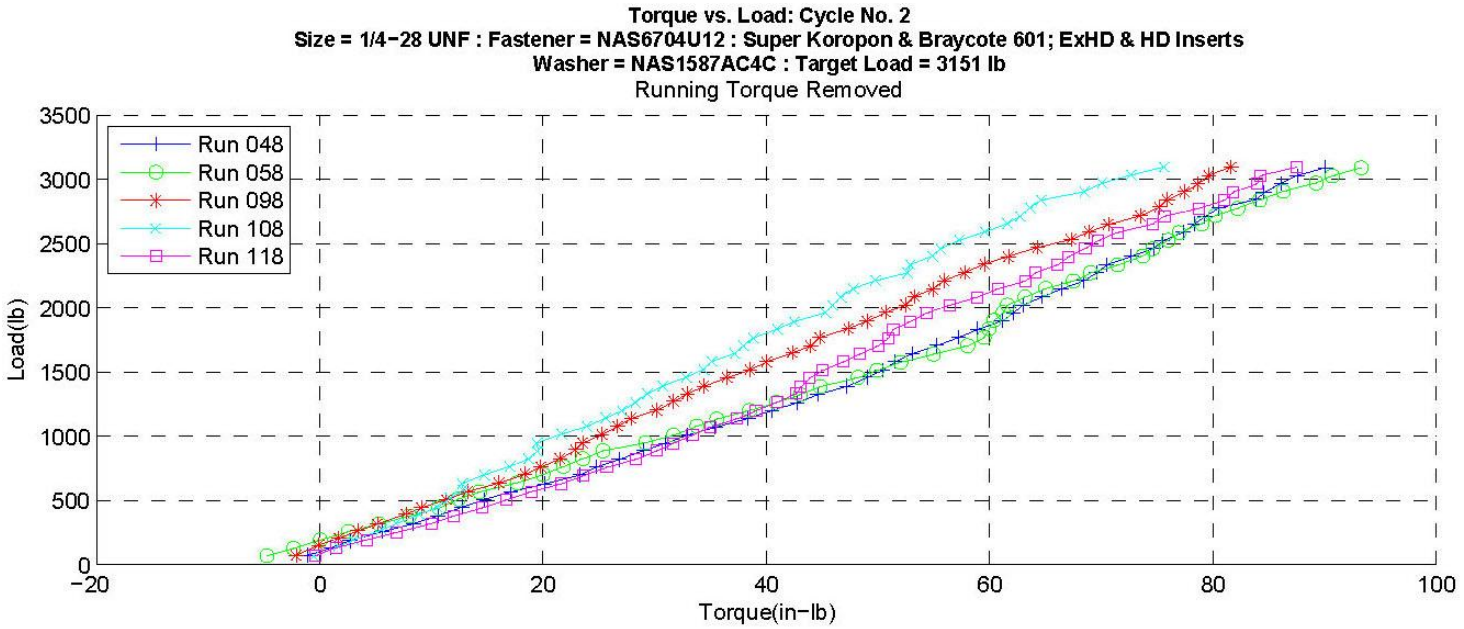

Running Torque Included
Run 010
Run 026
Run 077
Run 086
Run 096
Load(lb)
Torque(in-lb)

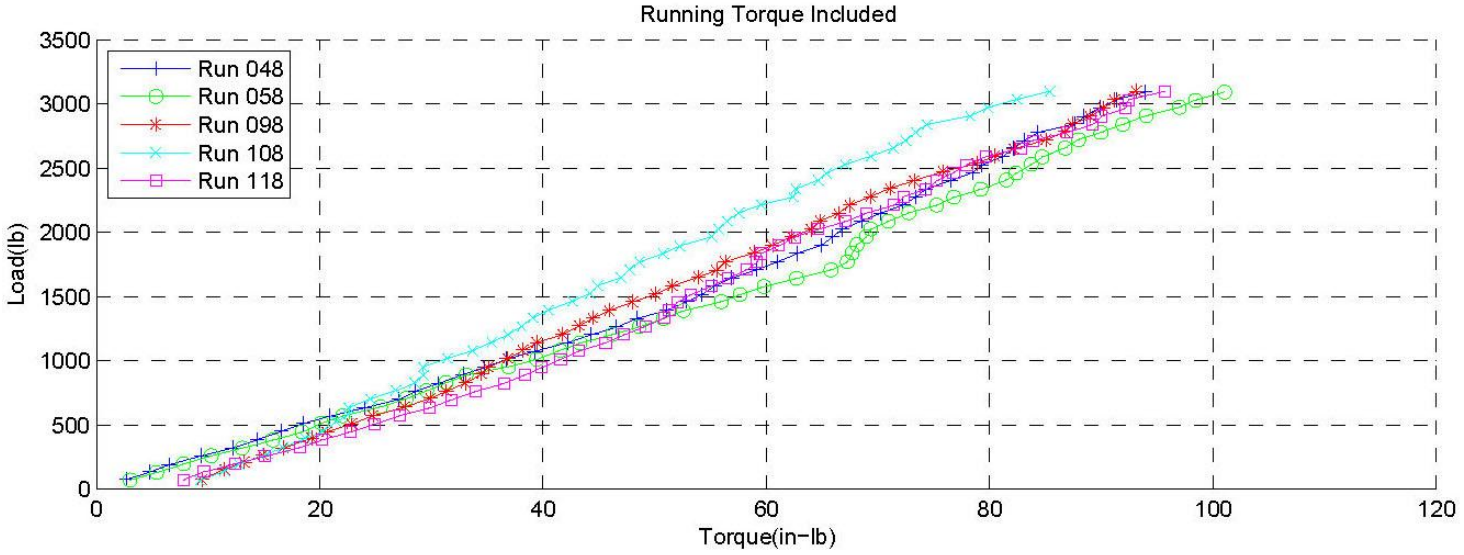
Appendix D:

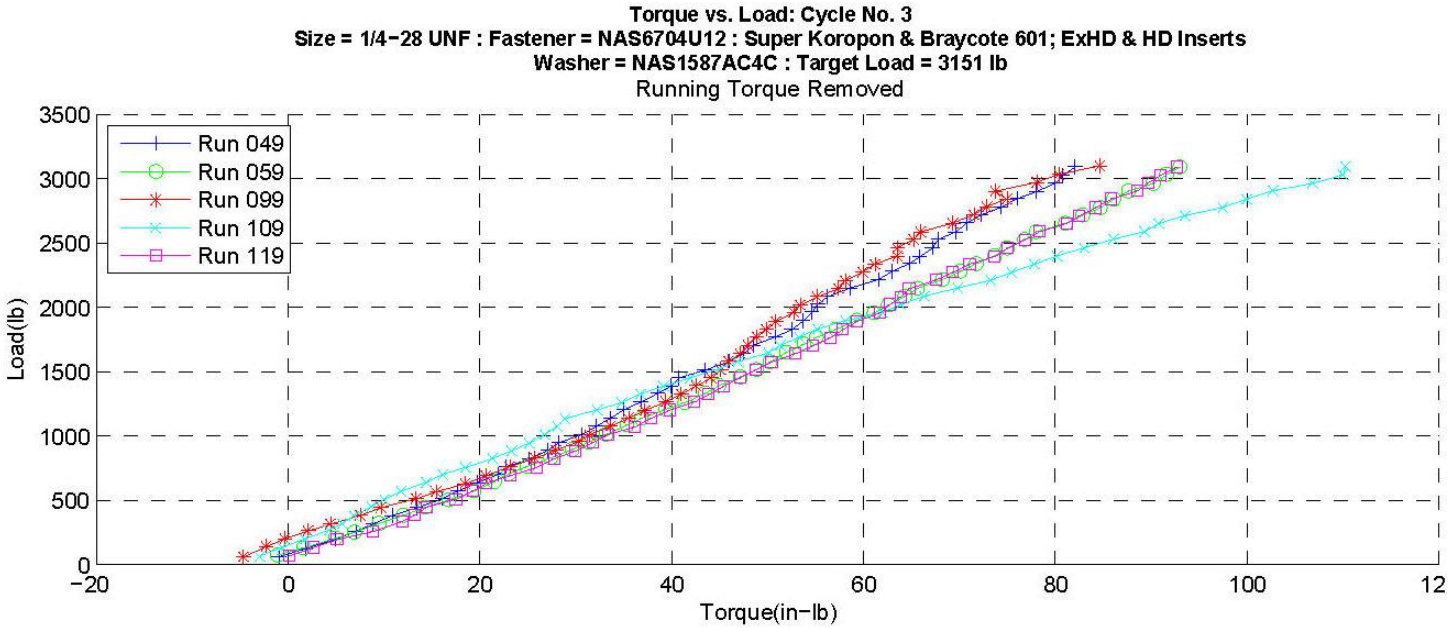
Section 1	1/4-28 No Braycote Torque Tension Plots
Section 2	1/4-28 Braycote 601 Torque Tension Plots
Section 3	1/4-28 Braycote 602 Torque Tension Plots
Section 4	1/4-28 No Braycote Running Torque Plots
Section 5	1/4-28 Braycote 601 Running Torque Plots
Section 6	1/4-28 Braycote 602 Running Torque Plots
Section 7	1/4-28 No Braycote Cycle Plots: Torque v. Load
Section 8	1/4-28 Braycote 601 Cycle Plots: Torque v. Load
Section 9	1/4-28 Braycote 602 Cycle Plots: Torque v. Load
Section 10	1/4-28 Friction Coefficients with Statistics
Section 11	1/4-28 Test Plate Layouts
Section 12	1/4-28 No Braycote Run Log
Section 13	1/4-28 Braycote 601 Run Logs
Section 14	1/4-28 Braycote 602 Run Logs

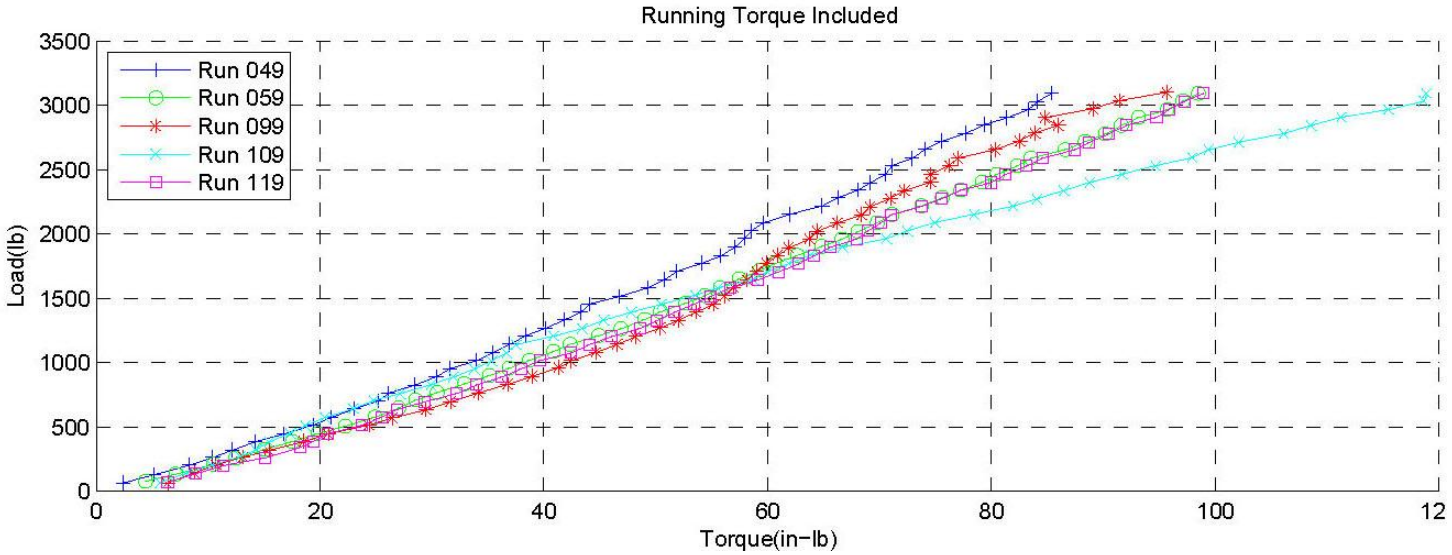

Torque vs. Load: Cycle No. 3
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & Bio[illegible]; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 047
Run 057
Run 097
Run 107
Run 117
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
-20
0
20
40
60
80
100
120

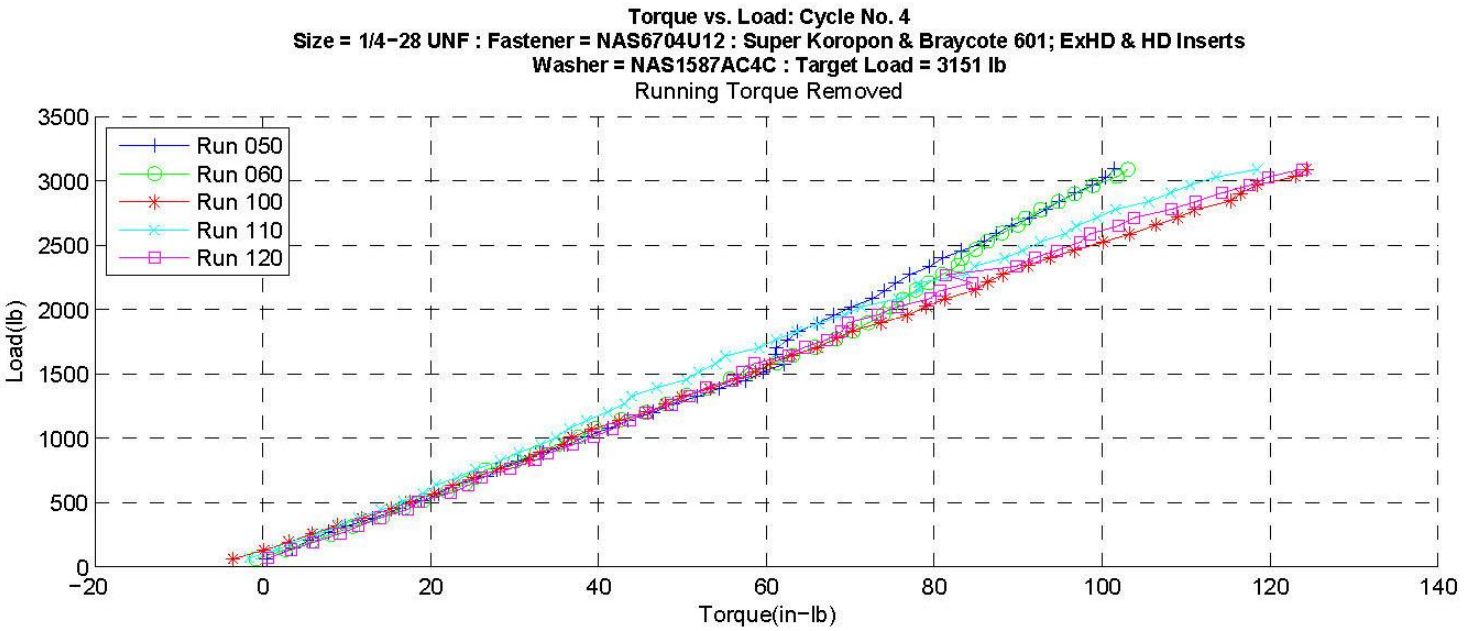

Running Torque Included
Run 047
Run 057
Run 097
Run 107
Run 117
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
120

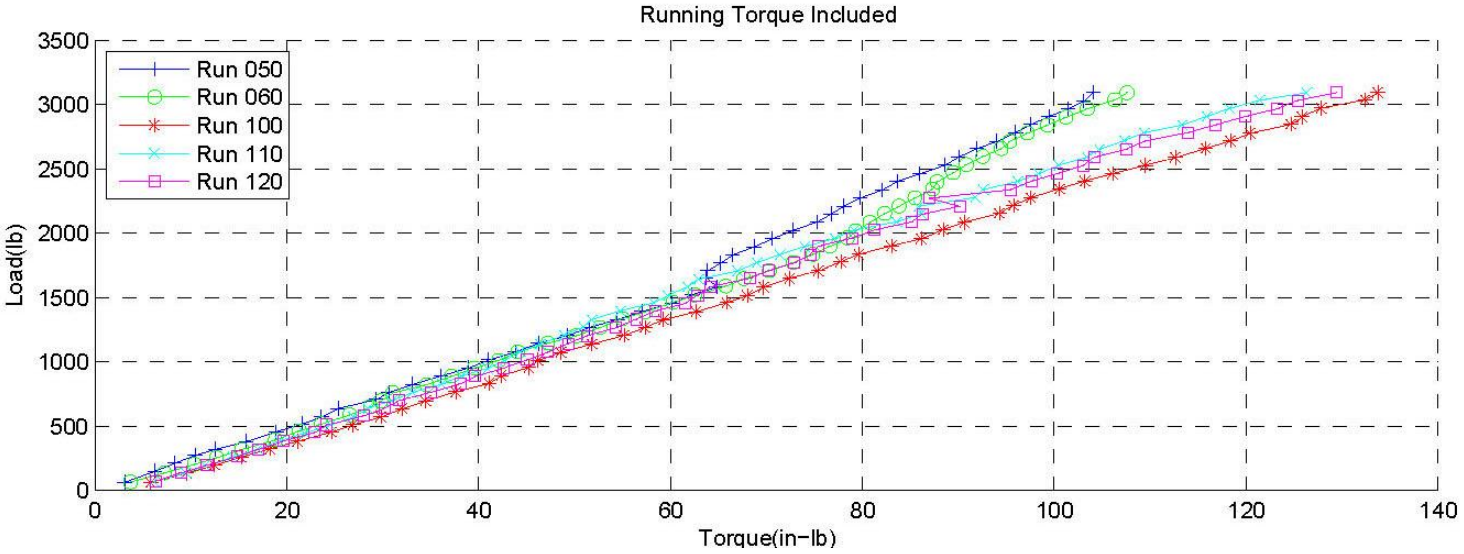

Torque vs. Load: Cycle No. 2
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & Braycote 601; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 048
Run 058
Run 098
Run 108
Run 118
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
-20
0
20
40
60
80
100

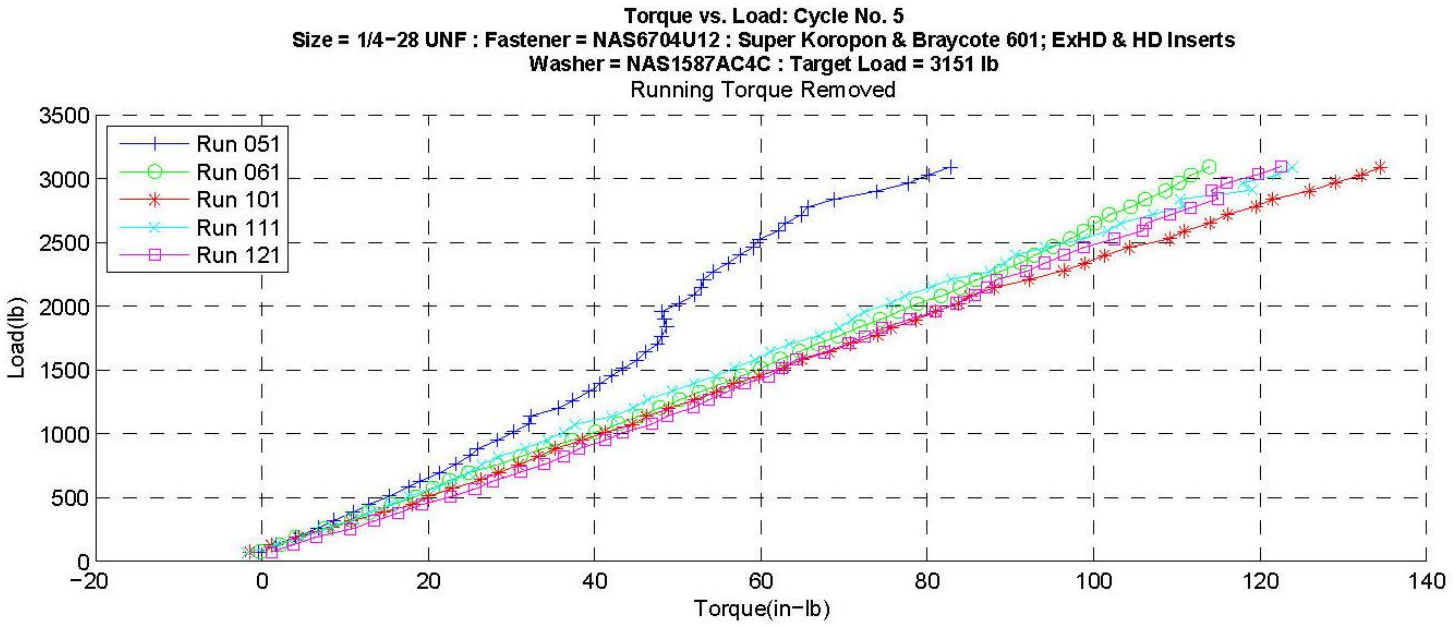

Running Torque Included
Run 048
Run 058
Run 098
Run 108
Run 118
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
120

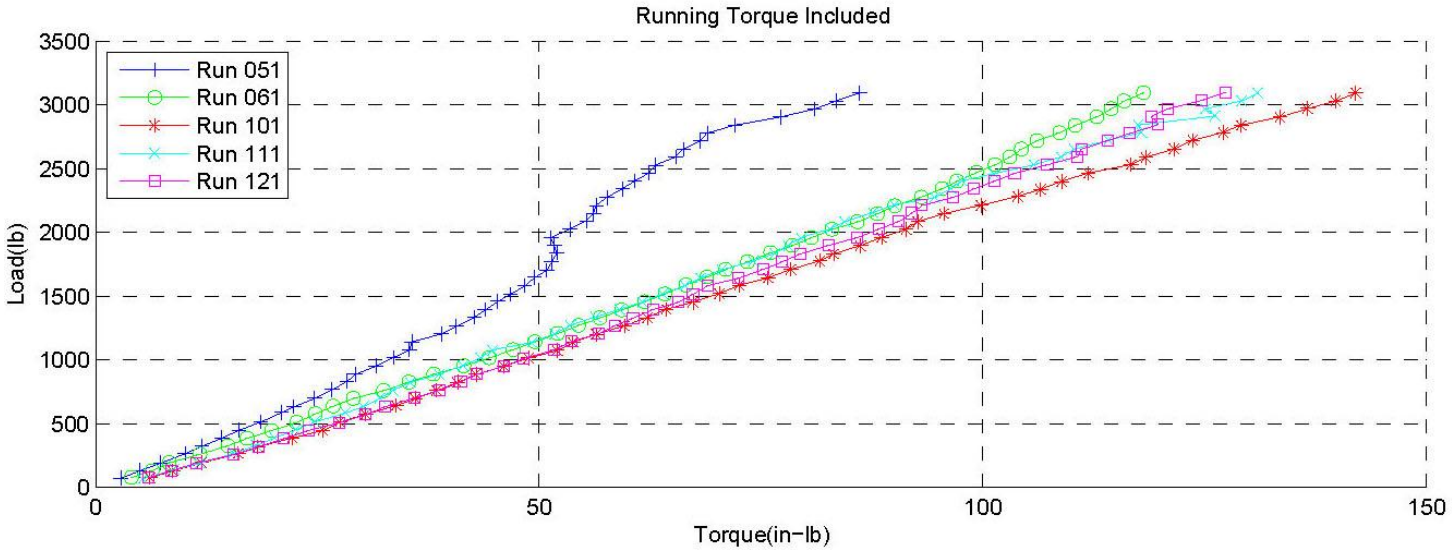

Torque vs. Load: Cycle No. 3
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & Braycote 601; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 049
Run 059
Run 099
Run 109
Run 119
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
-20
0
20
40
60
80
100
12

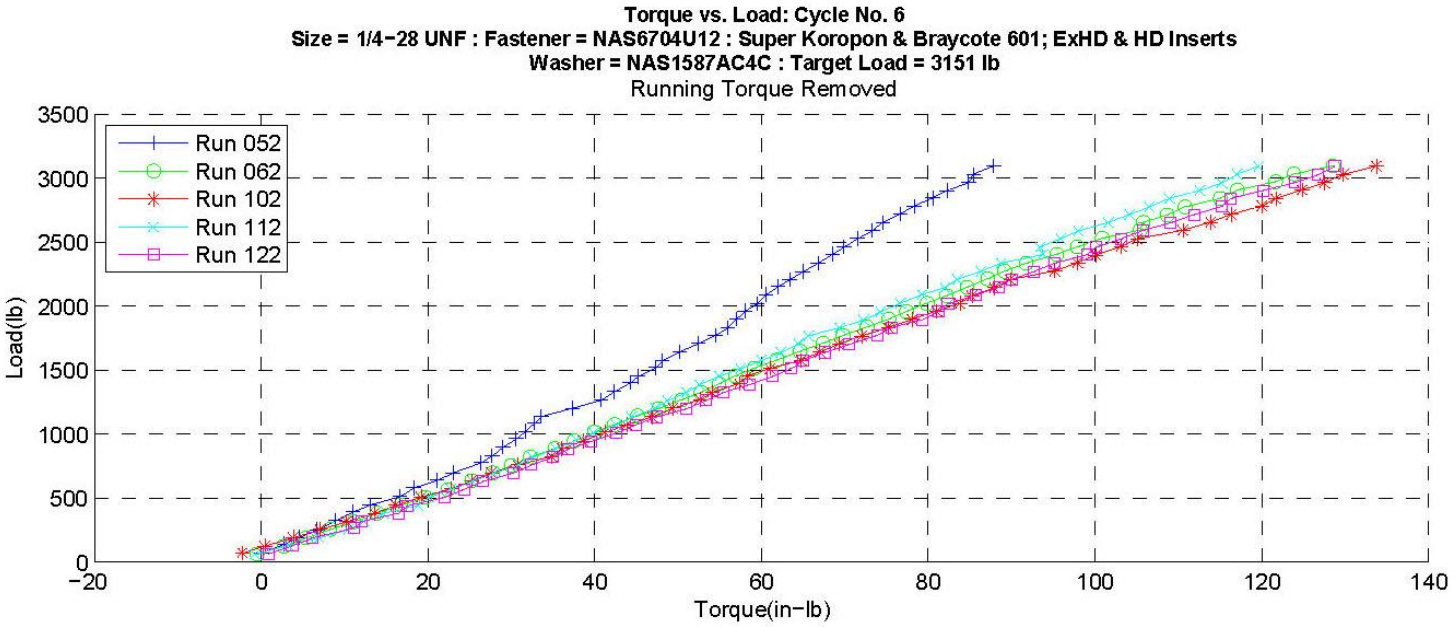

Running Torque Included
Run 049
Run 059
Run 099
Run 109
Run 119
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
12

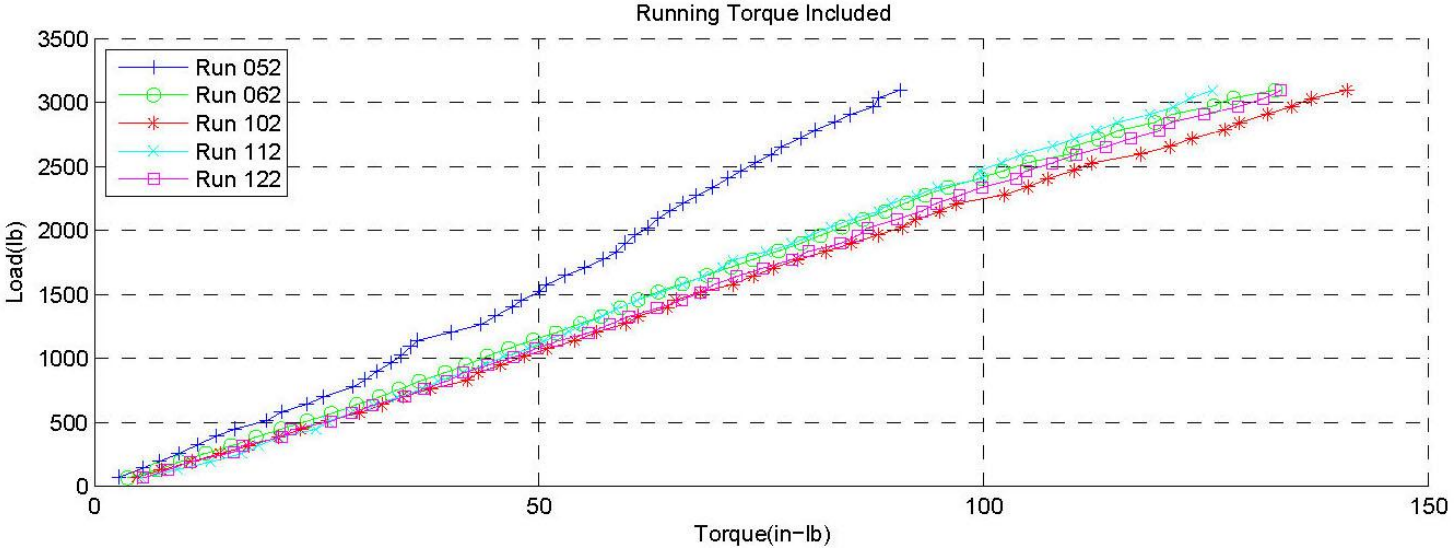

Torque vs. Load: Cycle No. 4
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & Braycote 601; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 050
Run 060
Run 100
Run 110
Run 120
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
-20
0
20
40
60
80
100
120
140

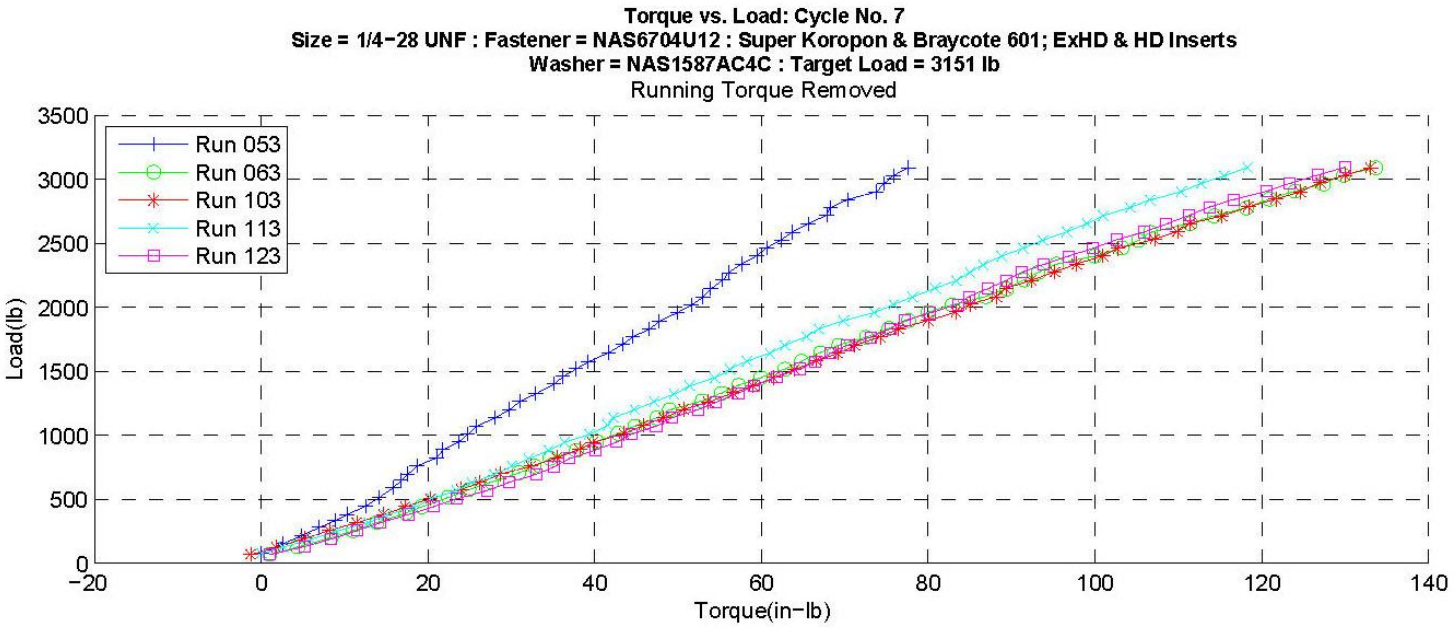

Running Torque Included
Run 050
Run 060
Run 100
Run 110
Run 120
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
120
140

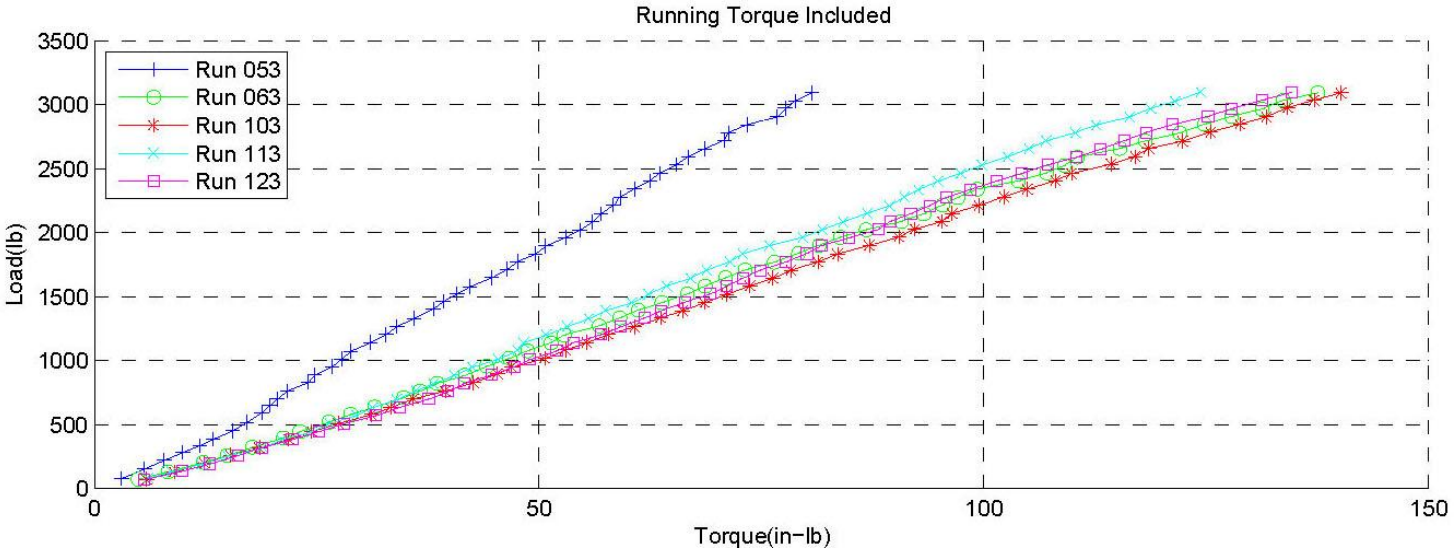

Torque vs. Load: Cycle No. 5
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & Braycote 601; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 051
Run 061
Run 101
Run 111
Run 121
Load(lb)
Torque(in-lb)
0
500
1000
1500
2000
2500
3000
3500
-20
0
20
40
60
80
100
120
140

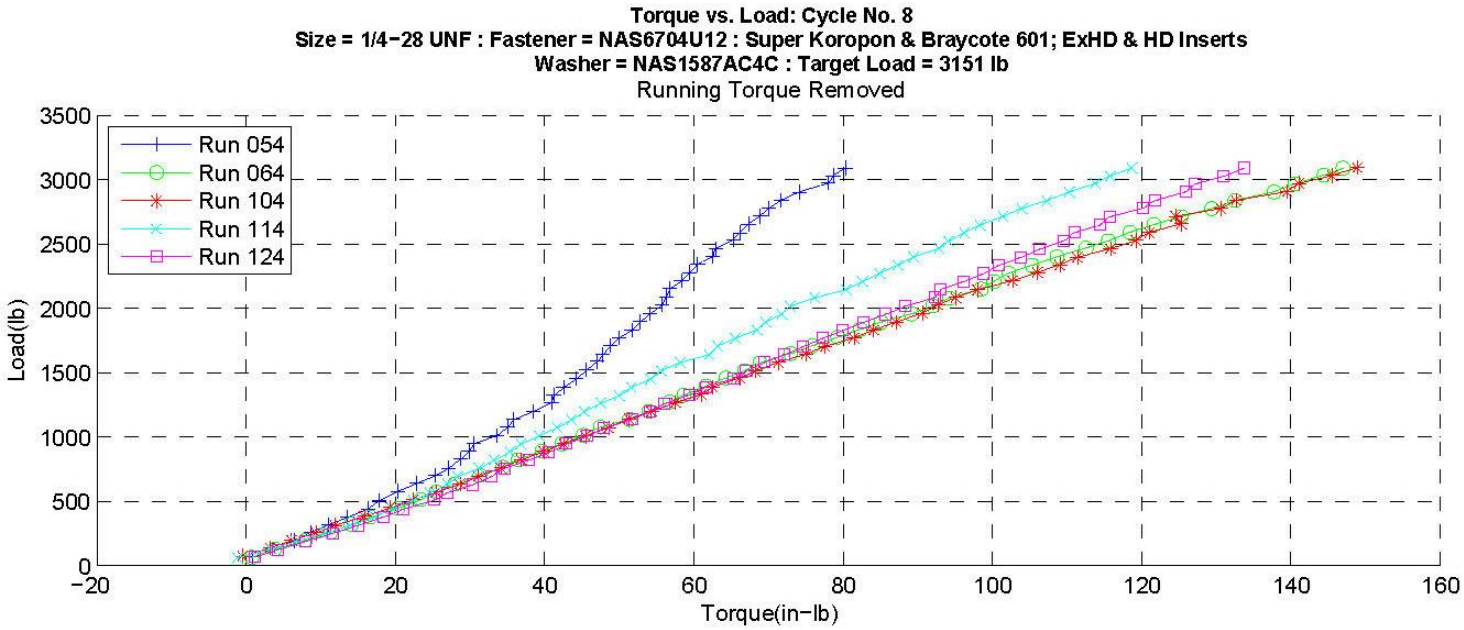

Running Torque Included
Run 051
Run 061
Run 101
Run 111
Run 121
Load(lb)
Torque(in-lb)
0
500
1000
1500
2000
2500
3000
3500
0
50
100
150

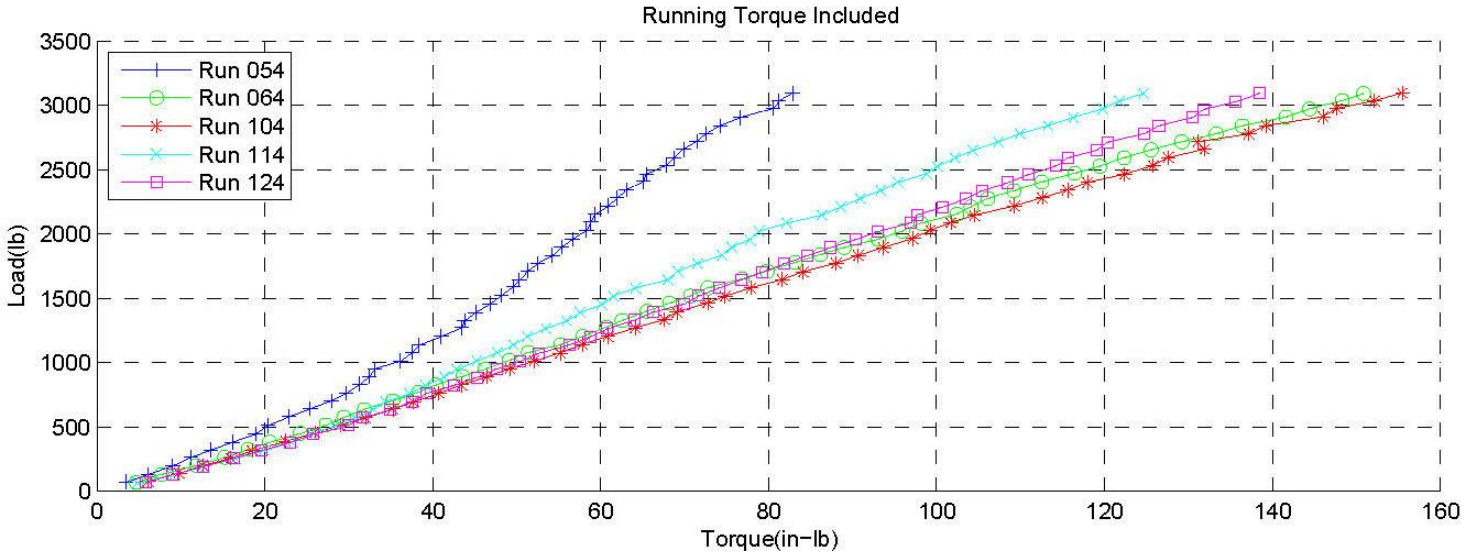

Torque vs. Load: Cycle No. 6
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & Braycote 601; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 052
Run 062
Run 102
Run 112
Run 122
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
-20
0
20
40
60
80
100
120
140

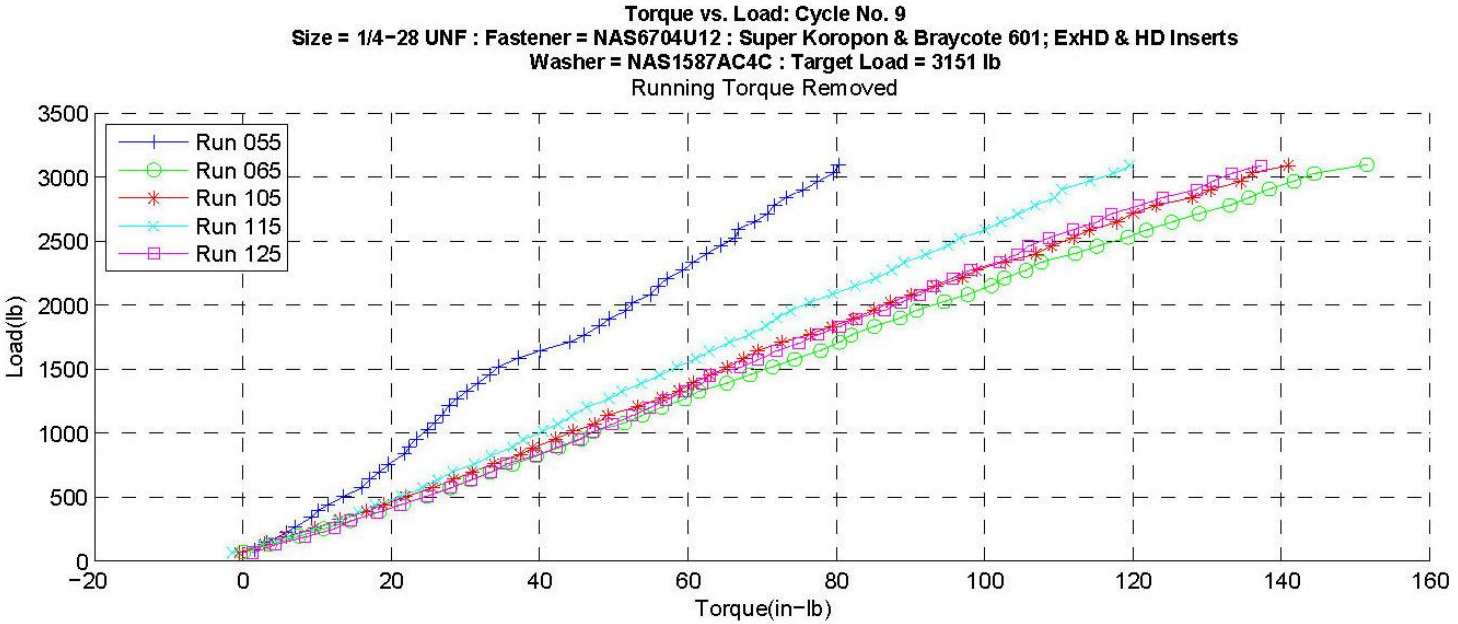

Running Torque Included
Run 052
Run 062
Run 102
Run 112
Run 122
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
0
50
100
150

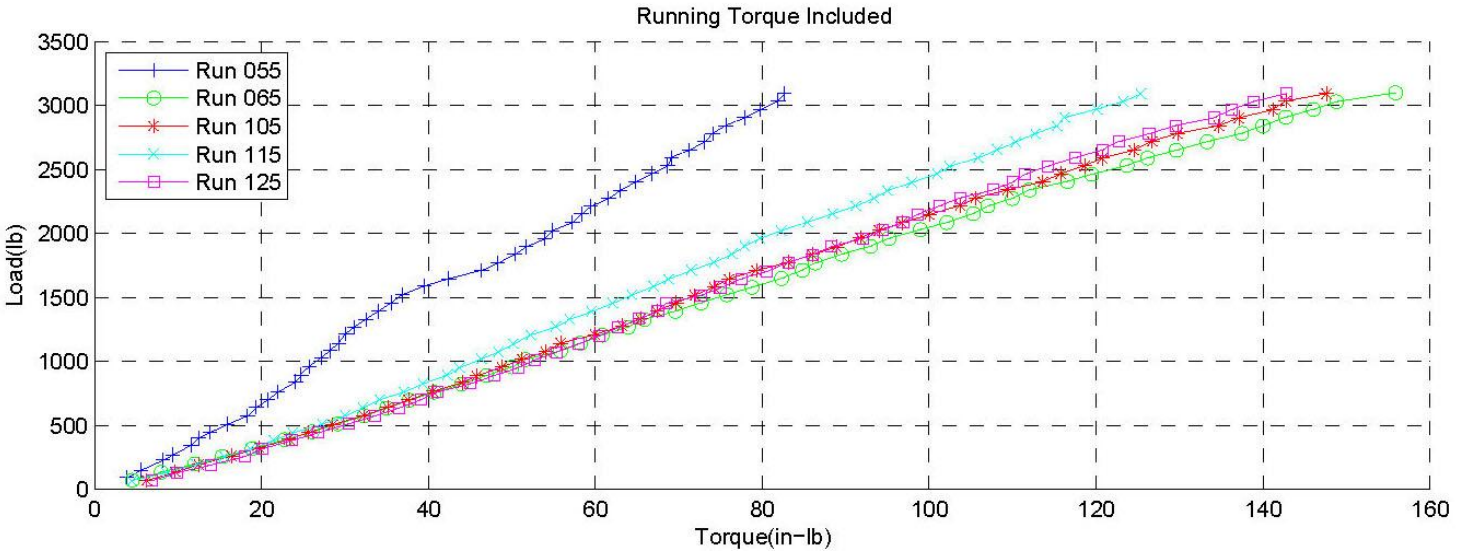

Torque vs. Load: Cycle No. 7
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & Braycote 601; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 053
Run 063
Run 103
Run 113
Run 123
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
-20
0
20
40
60
80
100
120
140

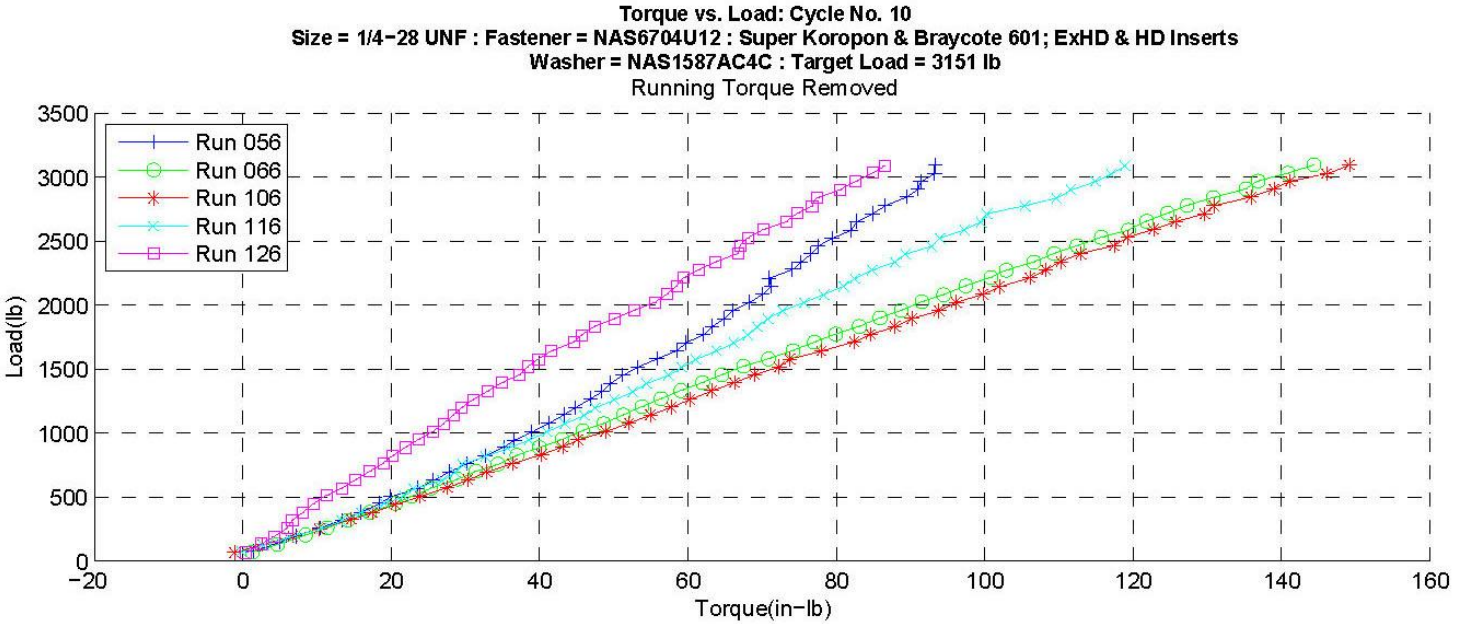

Running Torque Included
Run 053
Run 063
Run 103
Run 113
Run 123
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
0
50
100
150

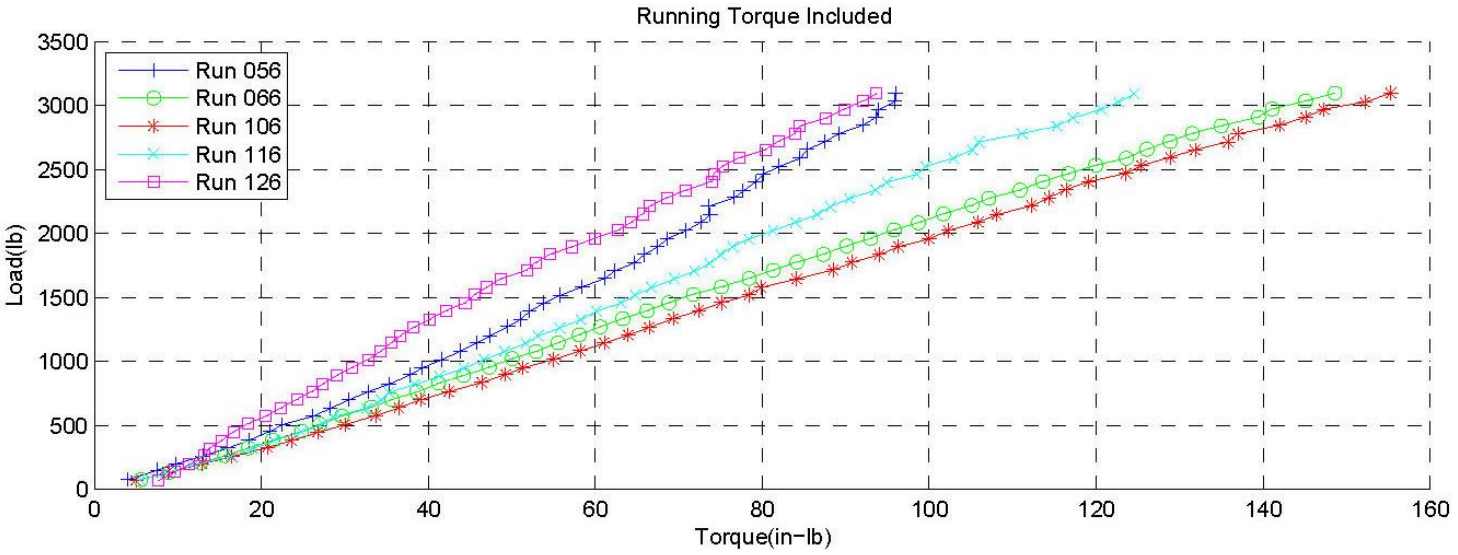

Torque vs. Load: Cycle No. 8
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & Braycote 601; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 054
Run 064
Run 104
Run 114
Run 124
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
-20
0
20
40
60
80
100
120
140
160


Running Torque Included
Run 054
Run 064
Run 104
Run 114
Run 124
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
120
140
160


Torque vs. Load: Cycle No. 9
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & Braycote 601; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 055
Run 065
Run 105
Run 115
Run 125
Load(lb)
Torque(in-lb)

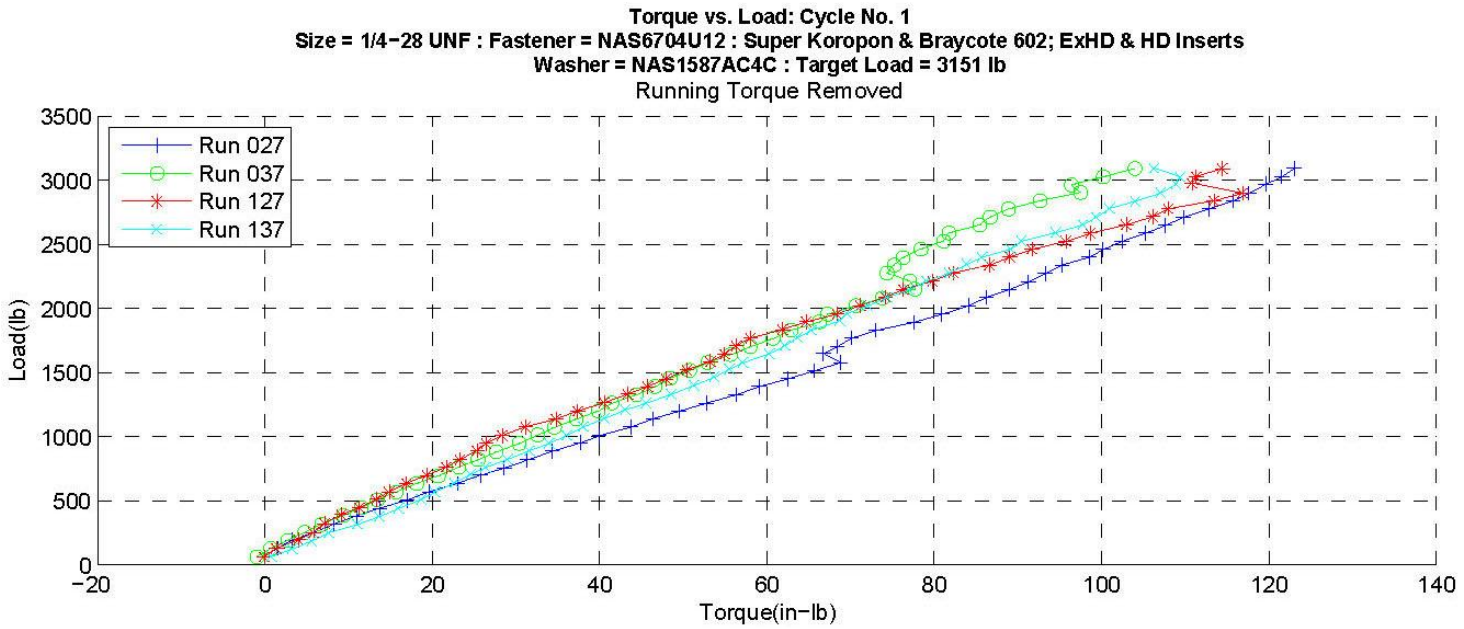

Running Torque Included
Run 055
Run 065
Run 105
Run 115
Run 125
Load(lb)
Torque(in-lb)

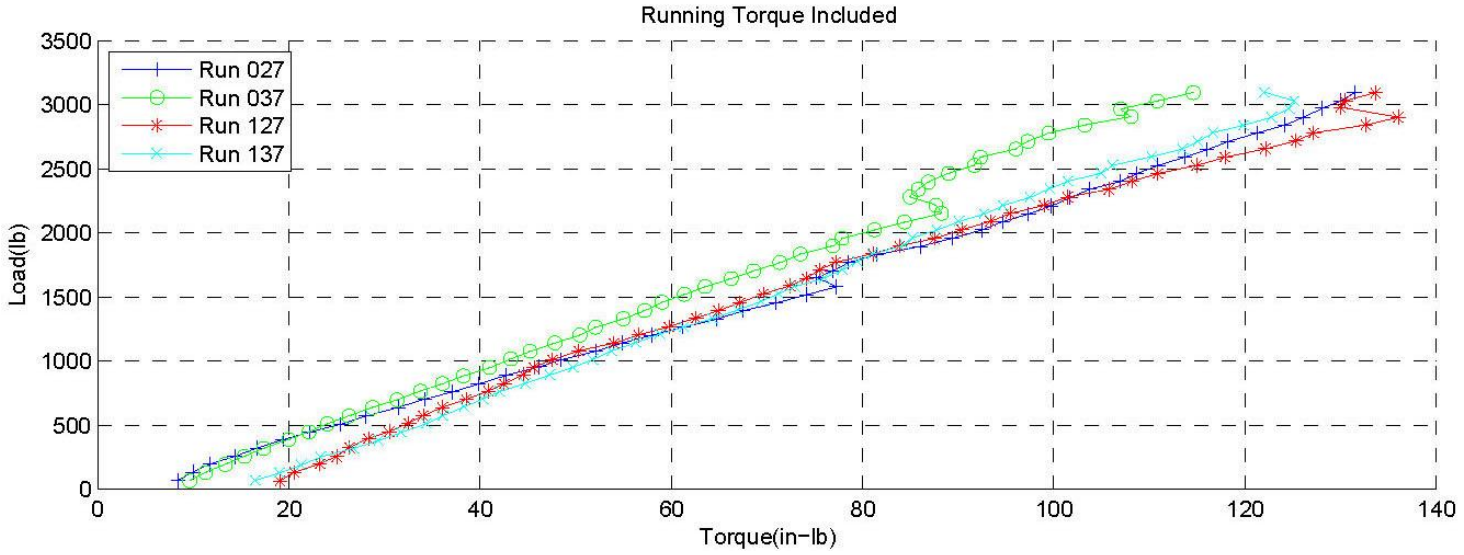

Torque vs. Load: Cycle No. 10
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & Braycote 601; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 056
Run 066
Run 106
Run 116
Run 126
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
-20
0
20
40
60
80
100
120
140
160

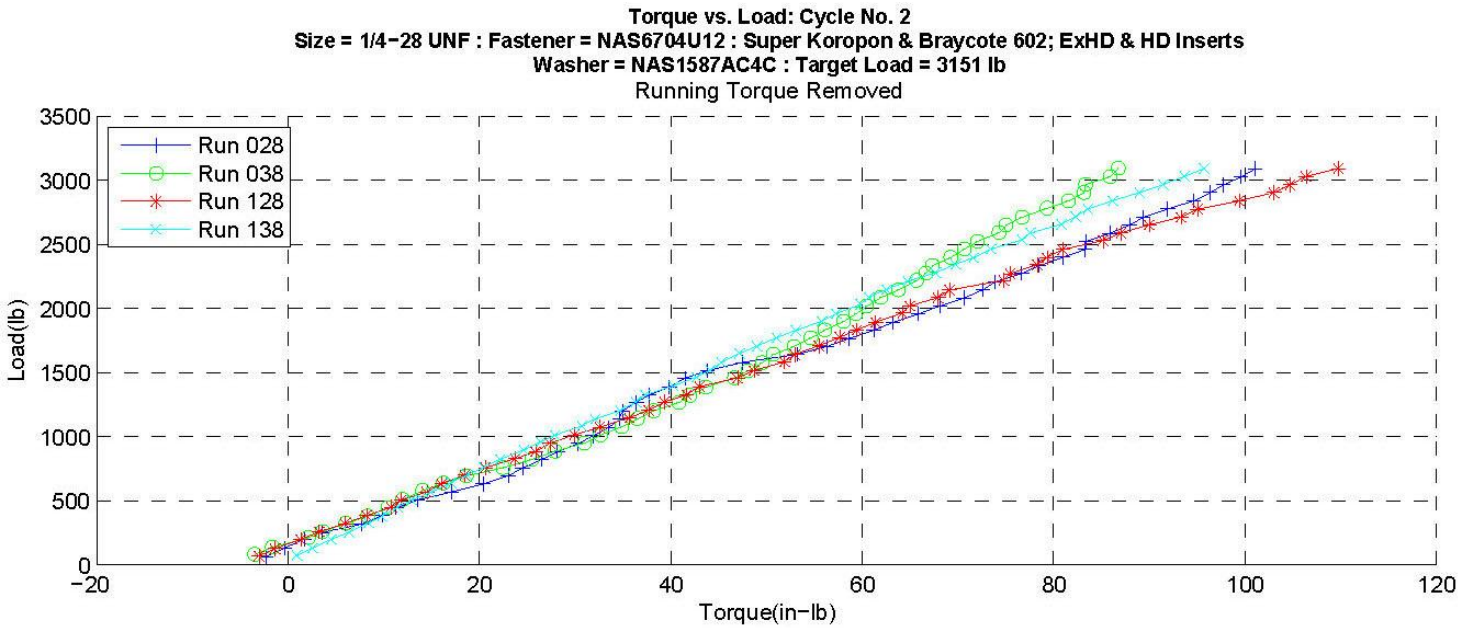

Running Torque Included
Run 056
Run 066
Run 106
Run 116
Run 126
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
120
140
160

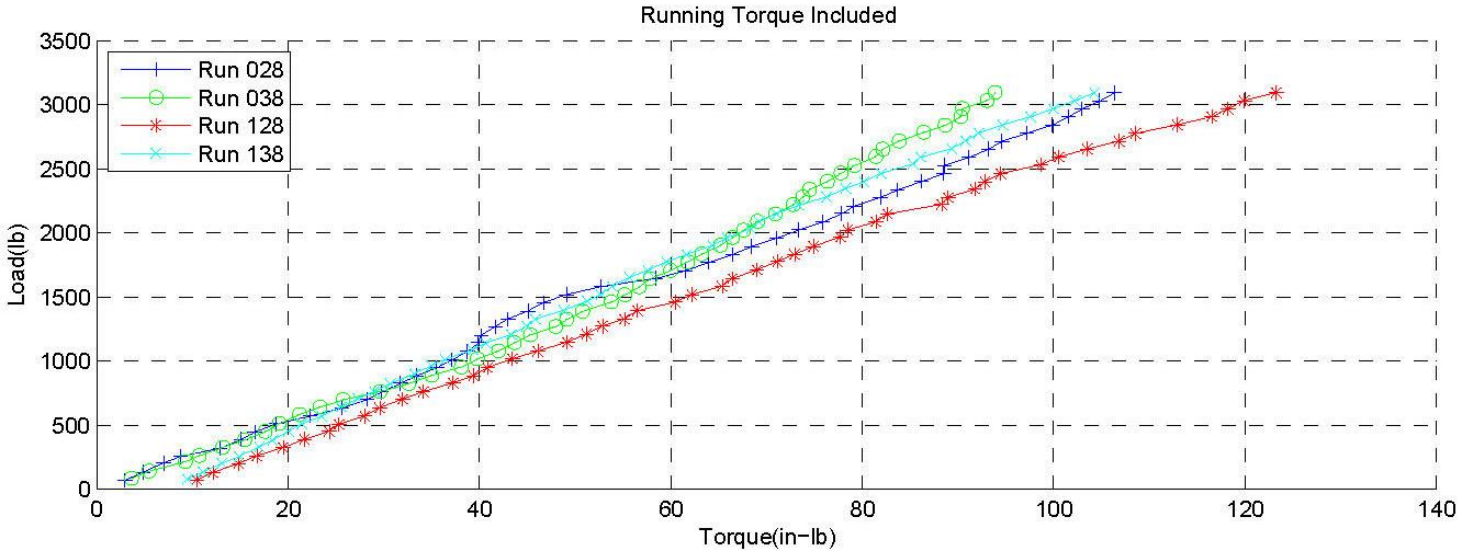
Appendix D:

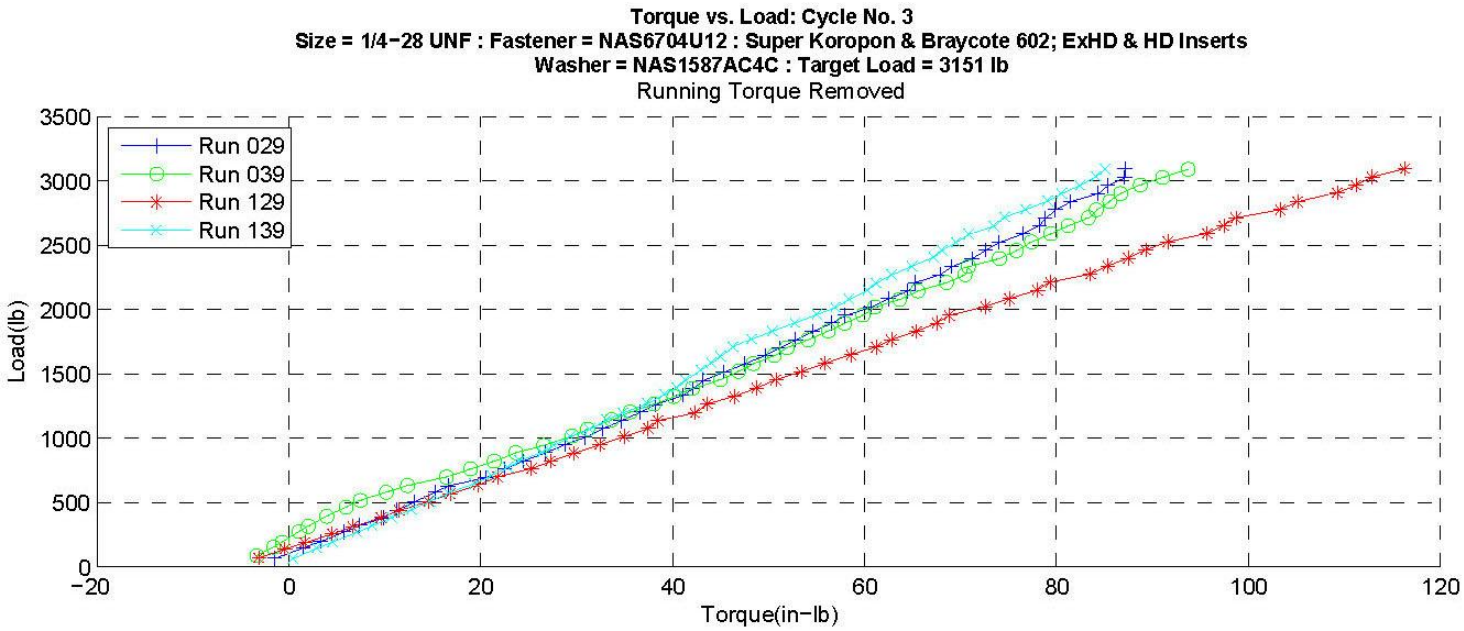
Section 1	1/4-28 No Braycote Torque Tension Plots
Section 2	1/4-28 Braycote 601 Torque Tension Plots
Section 3	1/4-28 Braycote 602 Torque Tension Plots
Section 4	1/4-28 No Braycote Running Torque Plots
Section 5	1/4-28 Braycote 601 Running Torque Plots
Section 6	1/4-28 Braycote 602 Running Torque Plots
Section 7	1/4-28 No Braycote Cycle Plots: Torque v. Load
Section 8	1/4-28 Braycote 601 Cycle Plots: Torque v. Load
Section 9	1/4-28 Braycote 602 Cycle Plots: Torque v. Load
Section 10	1/4-28 Friction Coefficients with Statistics
Section 11	1/4-28 Test Plate Layouts
Section 12	1/4-28 No Braycote Run Log
Section 13	1/4-28 Braycote 601 Run Logs
Section 14	1/4-28 Braycote 602 Run Logs

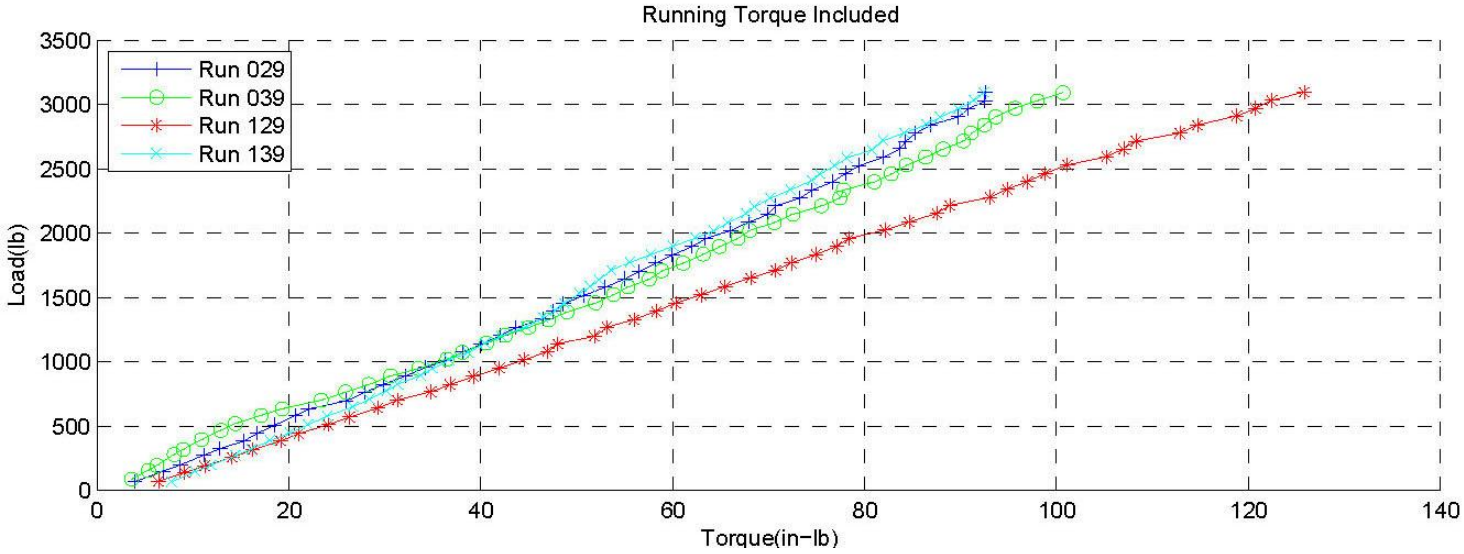

Torque vs. Load: Cycle No. 1
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & Braycote 602; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 027
Run 037
Run 127
Run 137
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
-20
0
20
40
60
80
100
120
140

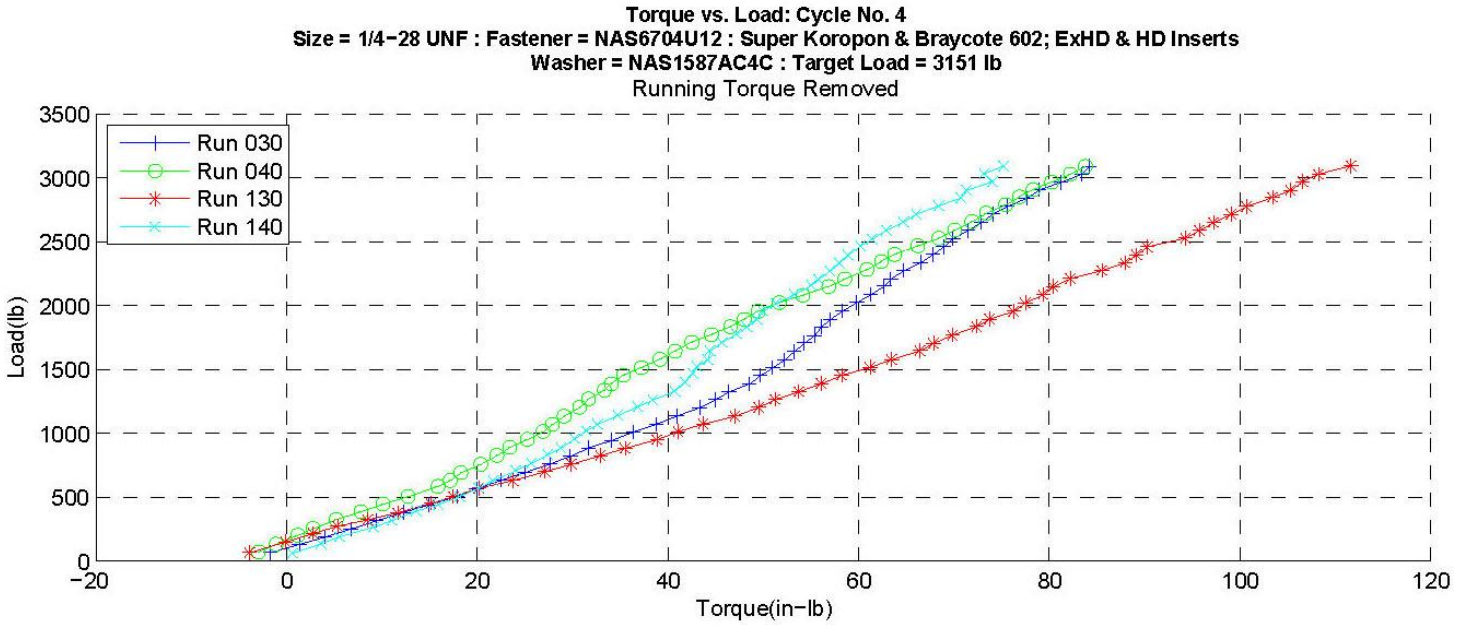

Running Torque Included
Run 027
Run 037
Run 127
Run 137
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
120
140

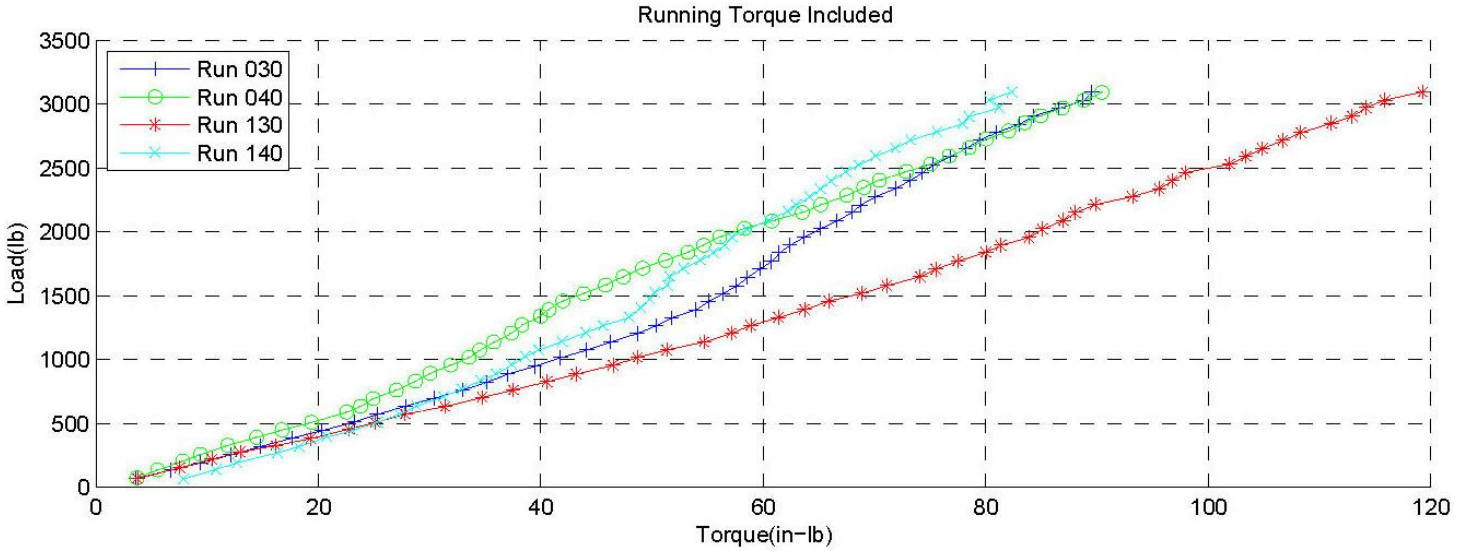

Torque vs. Load: Cycle No. 2
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & Braycote 602; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 028
Run 038
Run 128
Run 138
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
-20
0
20
40
60
80
100
120

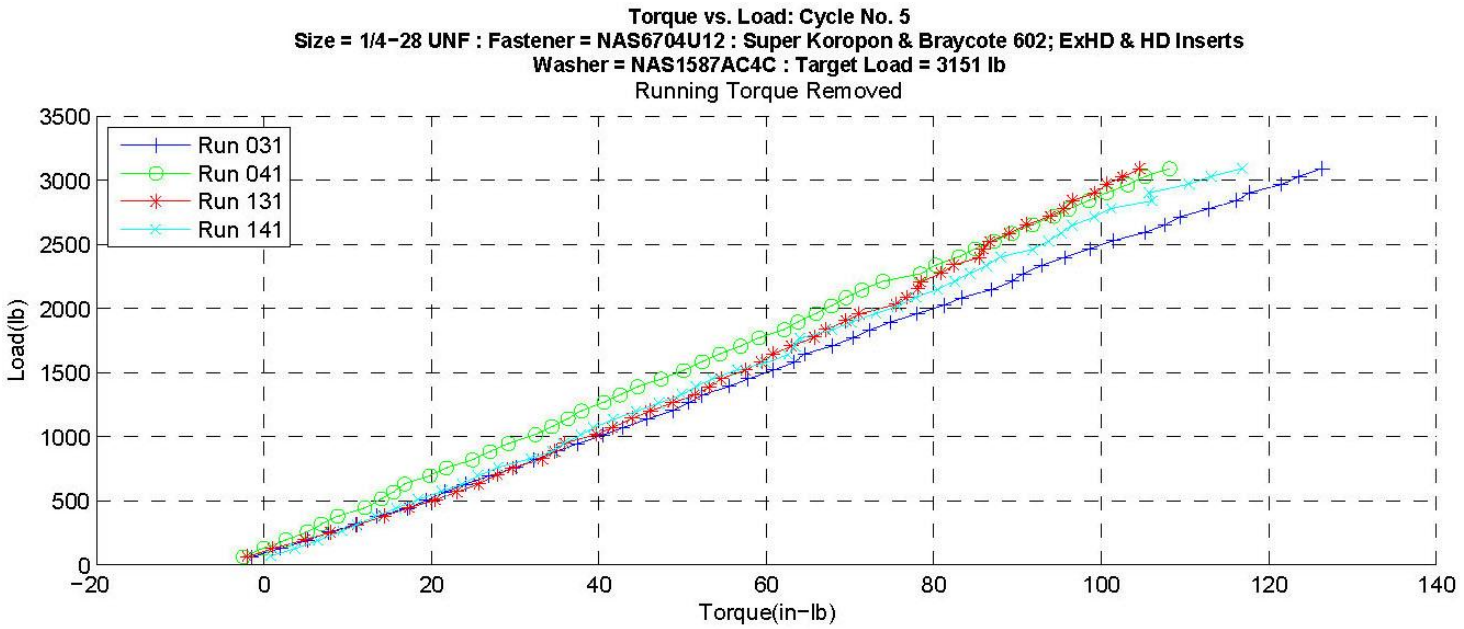

Running Torque Included
Run 028
Run 038
Run 128
Run 138
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
120
140

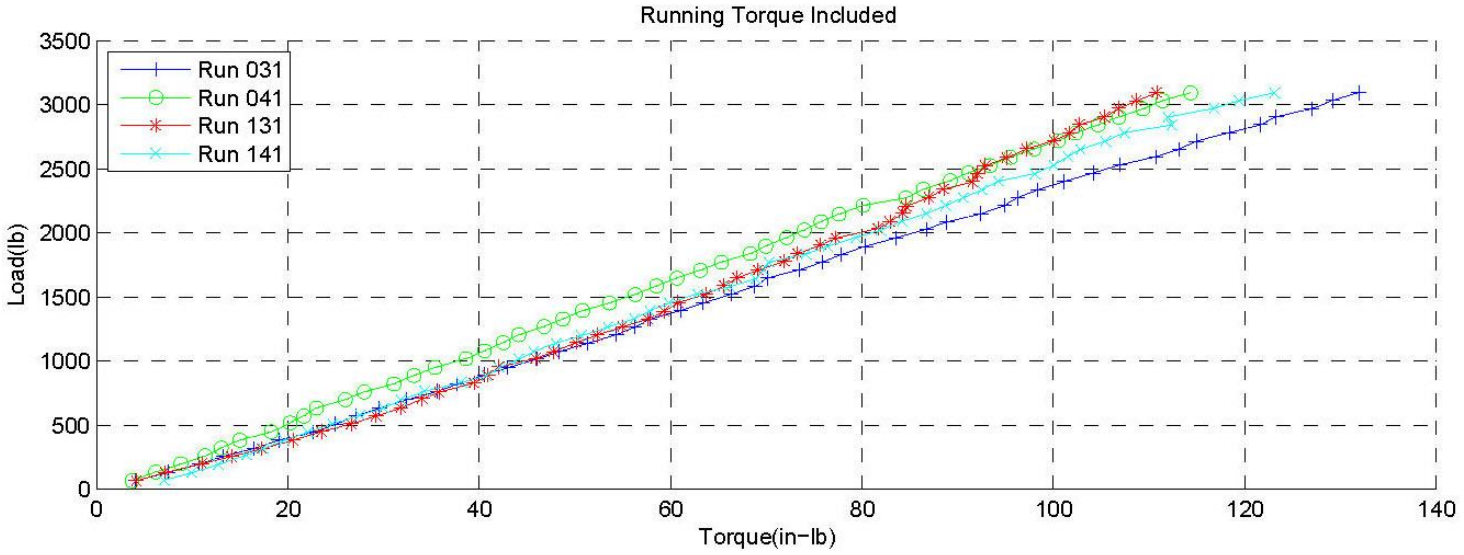

Torque vs. Load: Cycle No. 3
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & Braycote 602; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 029
Run 039
Run 129
Run 139
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
-20
0
20
40
60
80
100
120

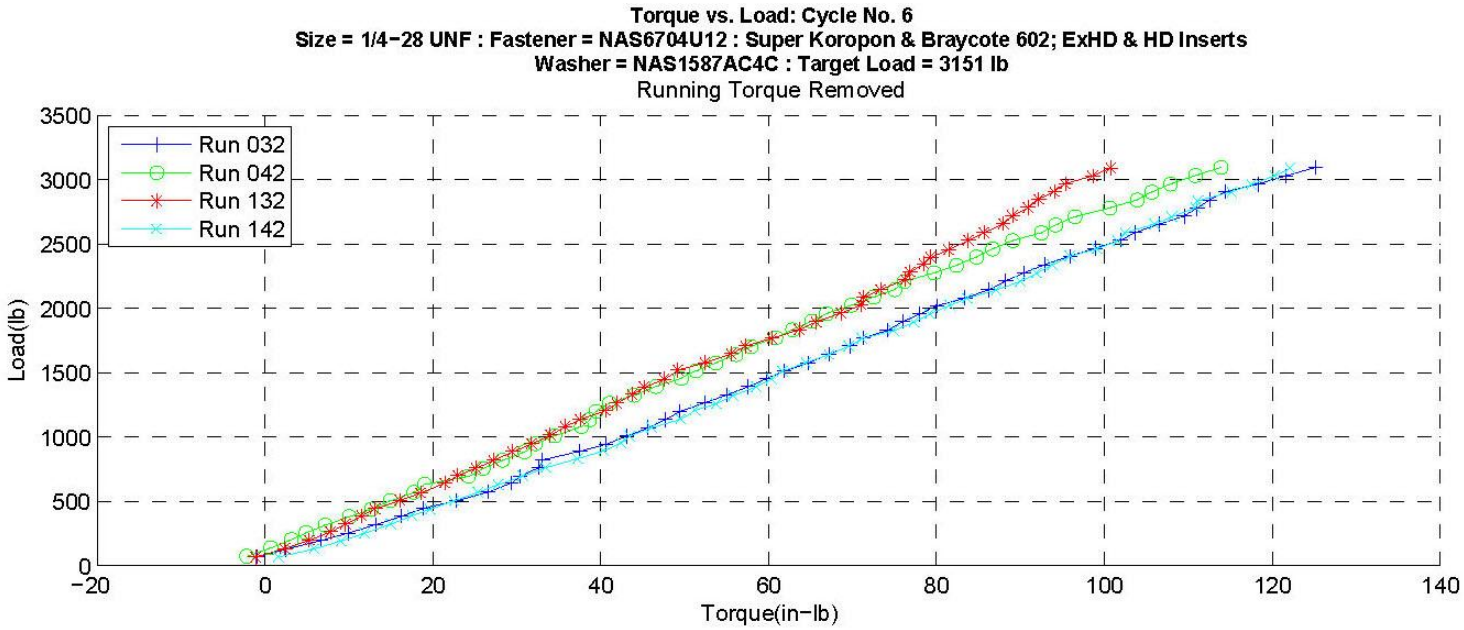

Running Torque Included
Run 029
Run 039
Run 129
Run 139
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
120
140

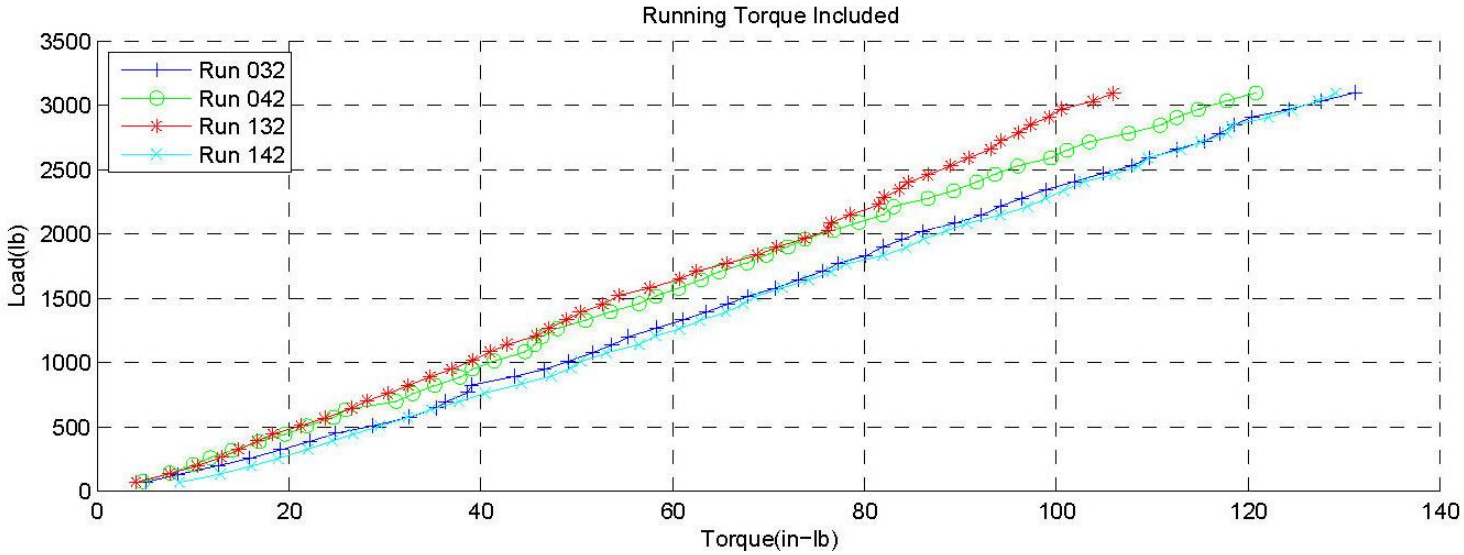

Torque vs. Load: Cycle No. 4
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & Braycote 602; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 030
Run 040
Run 130
Run 140
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
-20
0
20
40
60
80
100
120

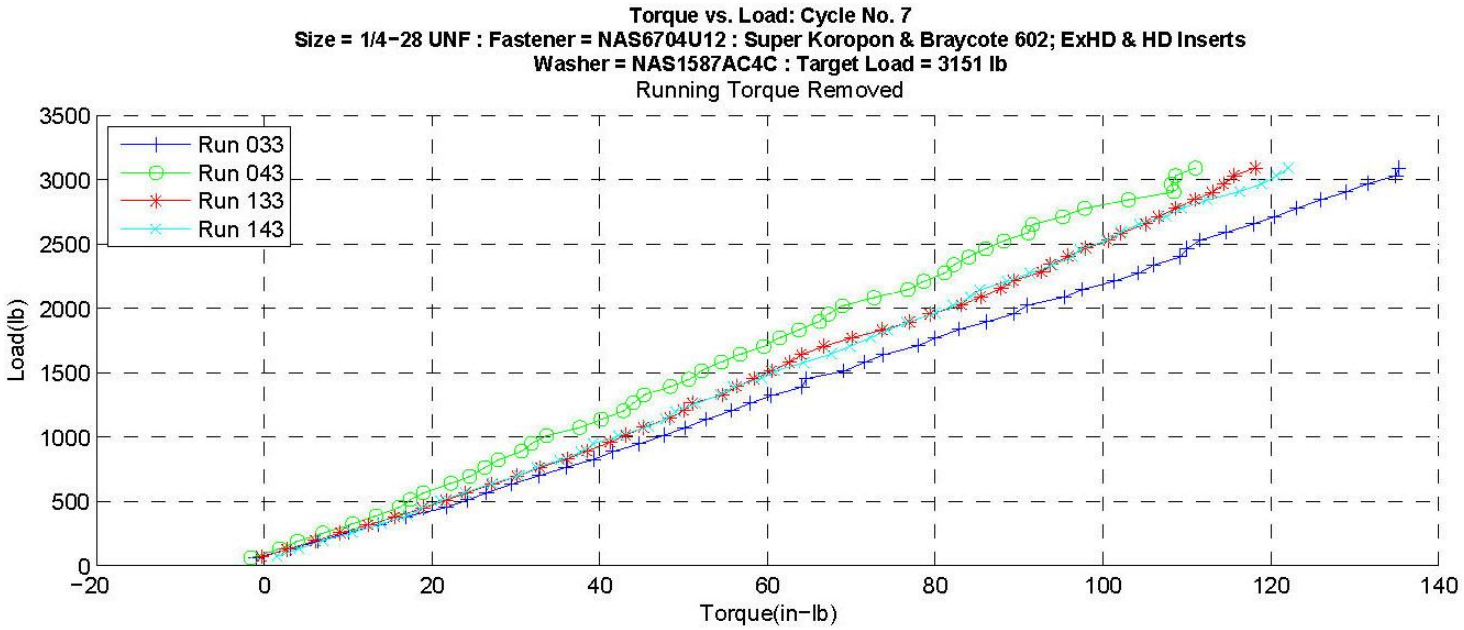

Running Torque Included
Run 030
Run 040
Run 130
Run 140
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
120

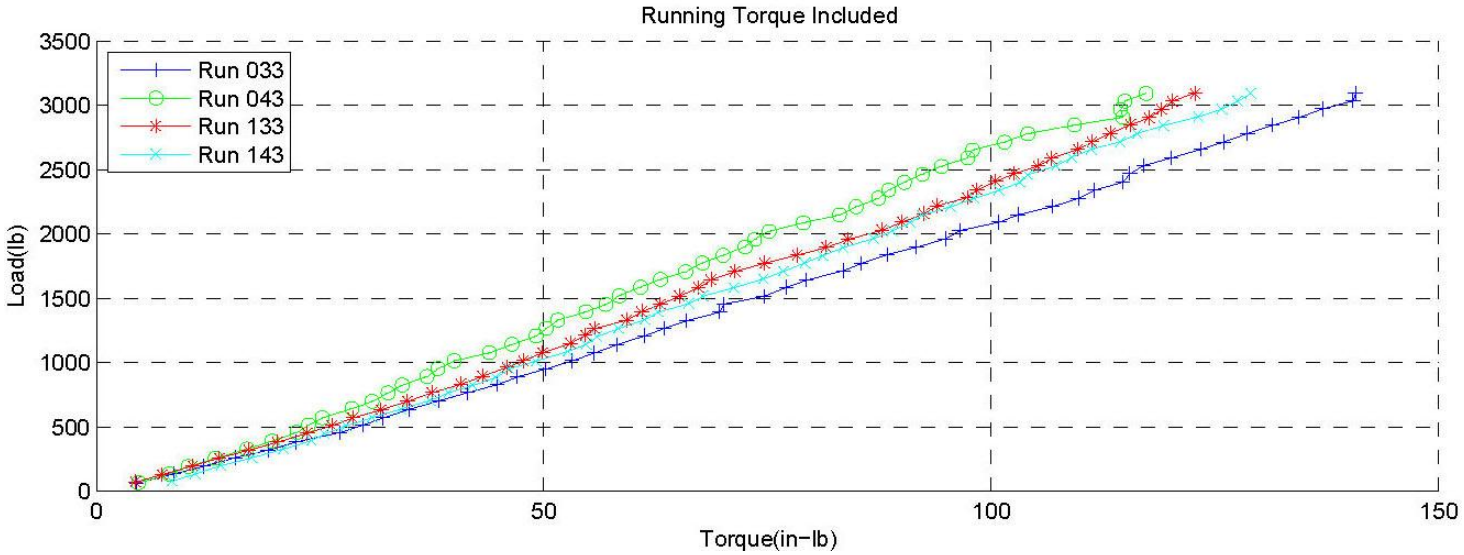

Torque vs. Load: Cycle No. 5
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & Braycote 602; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 031
Run 041
Run 131
Run 141
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
-20
0
20
40
60
80
100
120
140

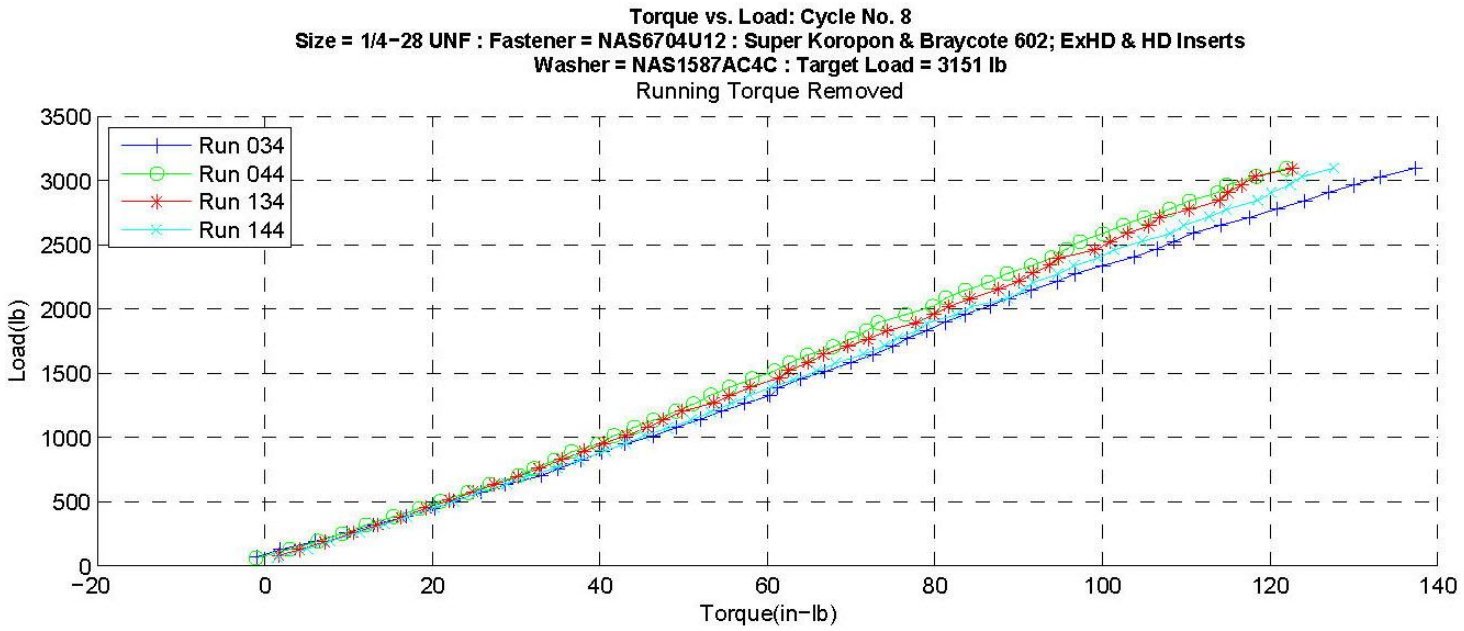

Running Torque Included
Run 031
Run 041
Run 131
Run 141
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
120
140

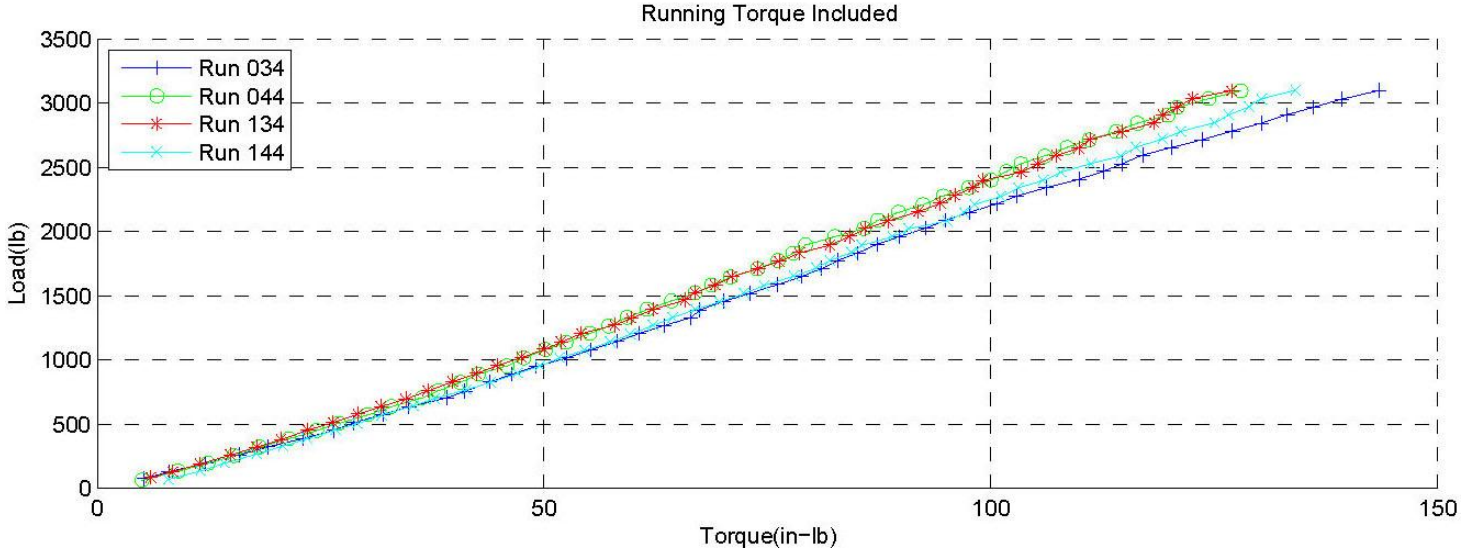

Torque vs. Load: Cycle No. 6
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & Braycote 602; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 032
Run 042
Run 132
Run 142
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
-20
0
20
40
60
80
100
120
140

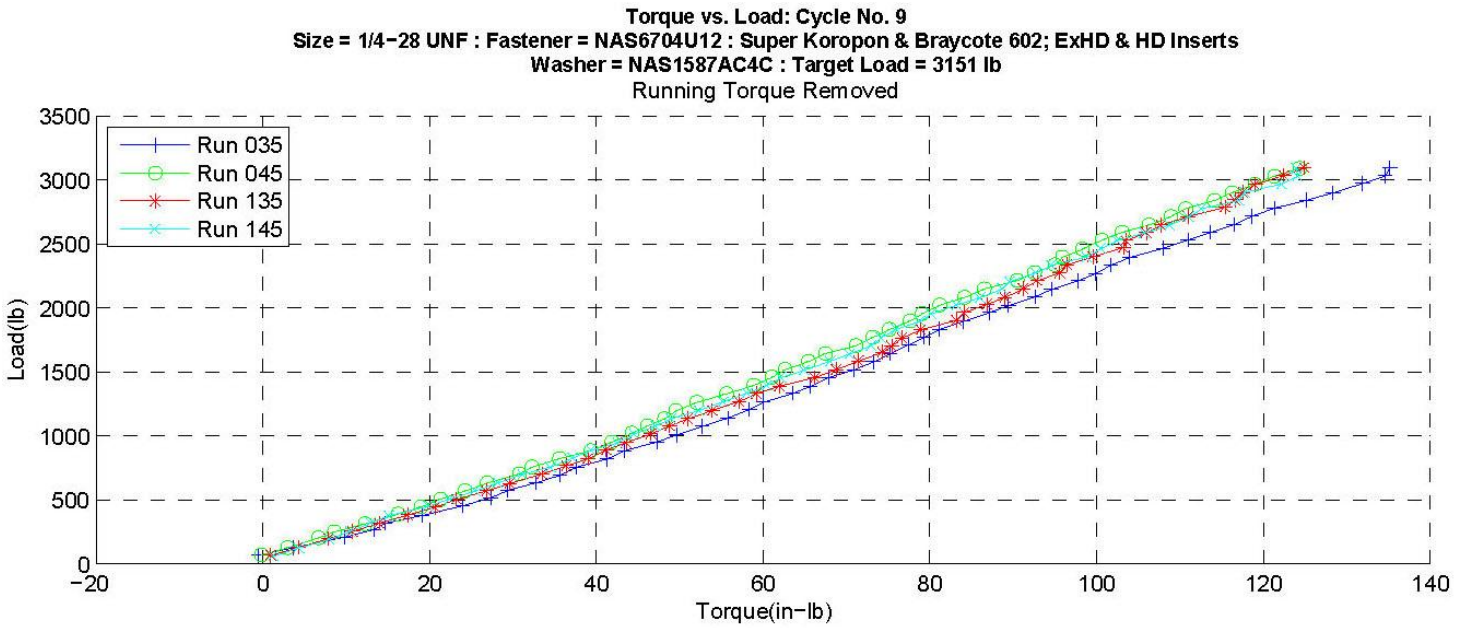

Running Torque Included
Run 032
Run 042
Run 132
Run 142
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
0
20
40
60
80
100
120
140

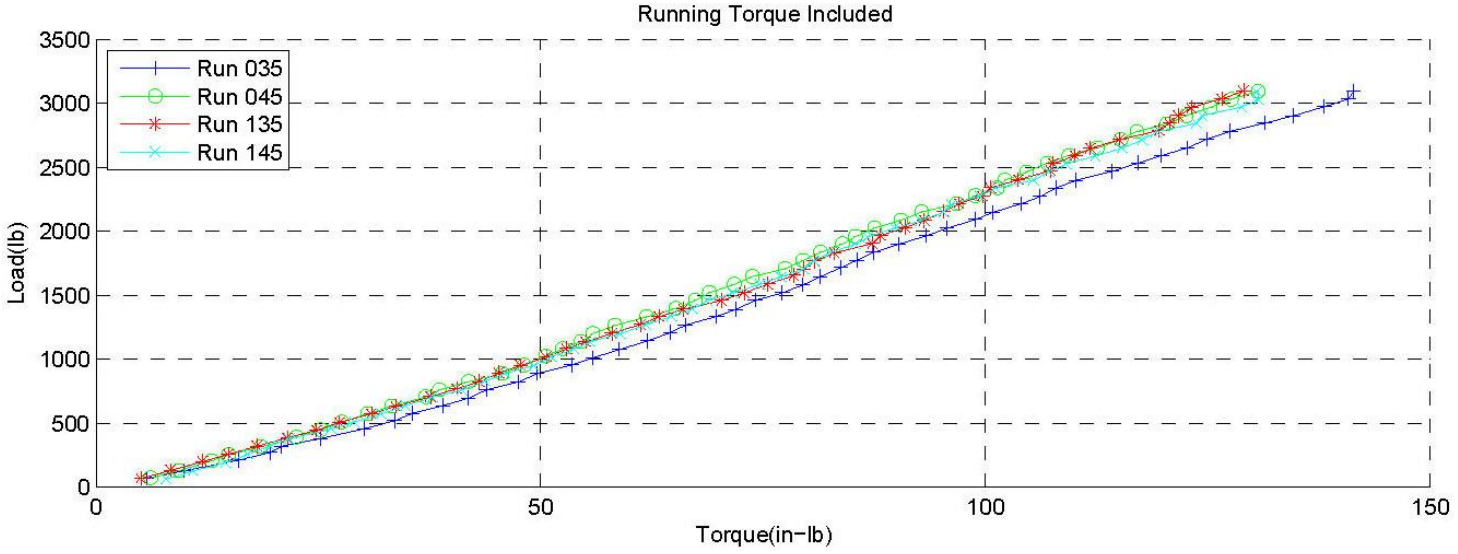

Torque vs. Load: Cycle No. 7
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & Braycote 602; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 033
Run 043
Run 133
Run 143
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
-20
0
20
40
60
80
100
120
140

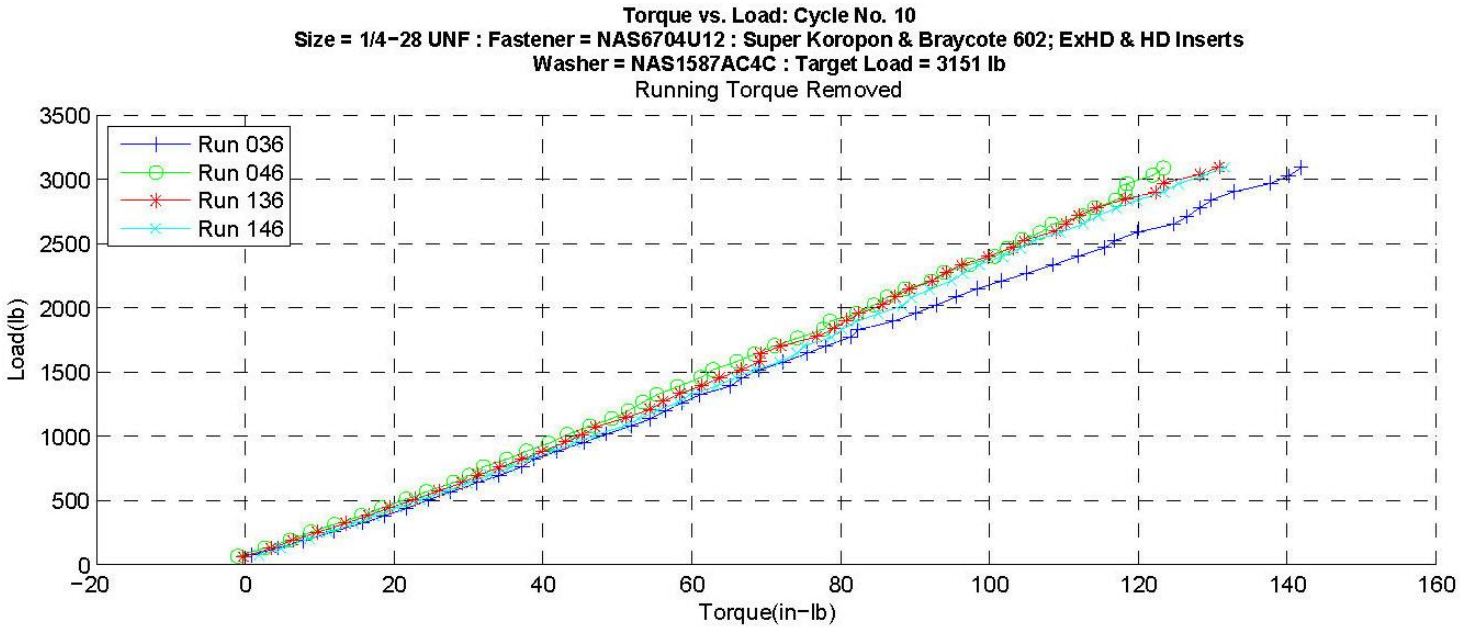

Running Torque Included
Run 033
Run 043
Run 133
Run 143
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
0
50
100
150

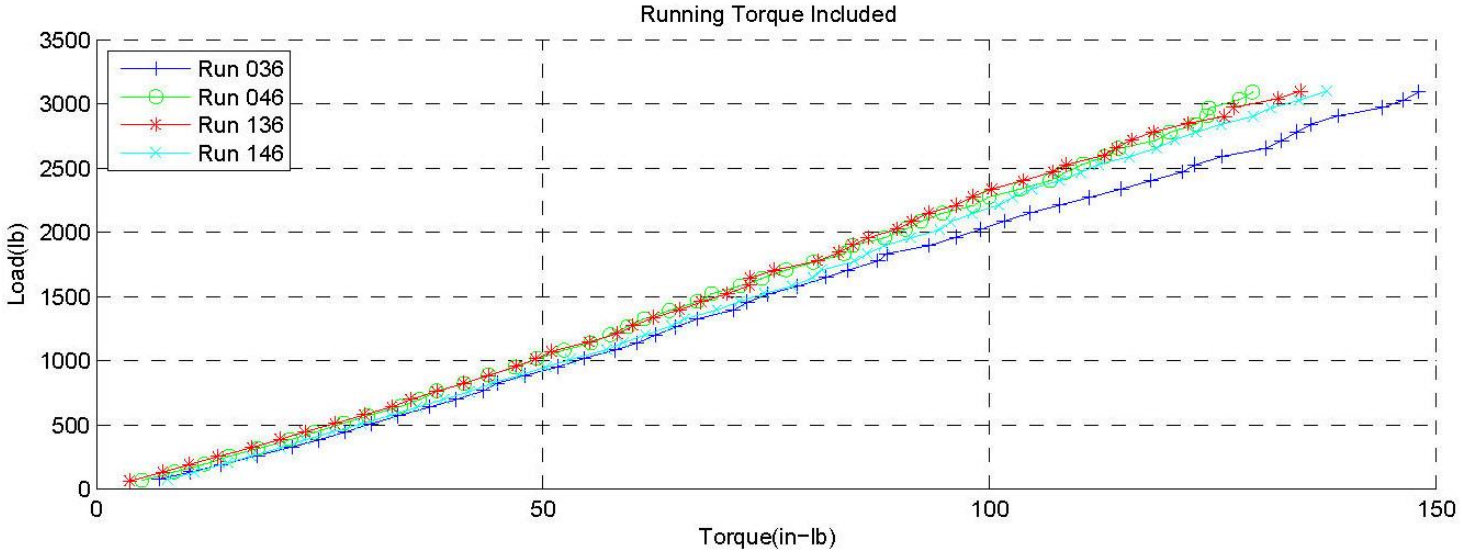

Torque vs. Load: Cycle No. 8
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & Braycote 602; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 034
Run 044
Run 134
Run 144
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
-20
0
20
40
60
80
100
120
140


Running Torque Included
Run 034
Run 044
Run 134
Run 144
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
0
50
100
150


Torque vs. Load: Cycle No. 9
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & Braycote 602; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 035
Run 045
Run 135
Run 145
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
-20
0
20
40
60
80
100
120
140


Running Torque Included
Run 035
Run 045
Run 135
Run 145
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
0
50
100
150


Torque vs. Load: Cycle No. 10
Size = 1/4-28 UNF : Fastener = NAS6704U12 : Super Koropon & Braycote 602; ExHD & HD Inserts
Washer = NAS1587AC4C : Target Load = 3151 lb
Running Torque Removed
Run 036
Run 046
Run 136
Run 146
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
-20
0
20
40
60
80
100
120
140
160


Running Torque Included
Run 036
Run 046
Run 136
Run 146
Load(lb)
Torque(in-lb)
3500
3000
2500
2000
1500
1000
500
0
0
50
100
150

Appendix D:

Section 1	1/4-28 No Braycote Torque Tension Plots
Section 2	1/4-28 Braycote 601 Torque Tension Plots
Section 3	1/4-28 Braycote 602 Torque Tension Plots
Section 4	1/4-28 No Braycote Running Torque Plots
Section 5	1/4-28 Braycote 601 Running Torque Plots
Section 6	1/4-28 Braycote 602 Running Torque Plots
Section 7	1/4-28 No Braycote Cycle Plots: Torque v. Load
Section 8	1/4-28 Braycote 601 Cycle Plots: Torque v. Load
Section 9	1/4-28 Braycote 602 Cycle Plots: Torque v. Load
Section 10	1/4-28 Friction Coefficients with Statistics
Section 11	1/4-28 Test Plate Layouts
Section 12	1/4-28 No Braycote Run Log
Section 13	1/4-28 Braycote 601 Run Logs
Section 14	1/4-28 Braycote 602 Run Logs

ORION TEST RESULTS for 0.25-28 NAS6704U12 FASTENERS (160KSI)

(Super Koropon Lube bolt head and washer, As Received Hardware, no cleaning, running torque removed)

TEST RUN NUMBER	TEST CYCLES INTO LOCKING EXHD KEENSERTS 1	2	3	4	5	6	7	8	9	10	INSERT #	Lube/Insert Type
1	0.176	0.171	0.173	0.169		0.172		0.162		0.192	1	ExHD No Braycote
17	0.153	0.148	0.140	0.178	0.157	0.174	0.146	0.150	0.149	0.170	2	ExHD No Braycote
47	0.138	0.117	0.106	0.131	0.107	0.113	0.100	0.104	0.104	0.121	3	ExHD Braycote 601
57	0.130	0.121	0.120	0.133	0.147	0.166	0.173	0.190	0.196	0.187	4	ExHD Braycote 601
27	0.159	0.131	0.113	0.109	0.163	0.162	0.175	0.177	0.175	0.183	5	ExHD Braycote 602
37	0.135	0.112	0.121	0.108	0.140	0.147	0.144	0.158	0.161	0.160	6	ExHD Braycote 602
67	0.111	0.107	0.110	0.102	0.104	0.110	0.111	0.170	0.165	0.168	7	HD No Braycote
77	0.131	0.131	0.138	0.144	0.149	0.178	0.178	0.185	0.132	0.122	8	HD No Braycote
87	0.119	0.126	0.132	0.169	0.172	0.179	0.186	0.197	0.192	0.213	9	HD No Braycote
97	0.105	0.105	0.109	0.161	0.174	0.173	0.172	0.192	0.182	0.193	10	HD Braycote 601
107	0.095	0.098	0.143	0.153	0.160	0.155	0.153	0.154	0.155	0.154	11	HD Braycote 601
117	0.106	0.113	0.120	0.160	0.158	0.166	0.168	0.173	0.178	0.112	12	HD Braycote 601
127	0.148	0.142	0.150	0.144	0.135	0.130	0.153	0.159	0.161	0.169	13	HD Braycote 602
137	0.137	0.124	0.110	0.097	0.151	0.158	0.158	0.165	0.160	0.170	14	HD Braycote 602

0.176	0.171	0.173	0.178	0.174	0.179	0.186	0.197	0.196	0.213		MAX
0.095	0.098	0.106	0.097	0.104	0.110	0.100	0.104	0.104	0.112		MIN
1.843	1.746	1.785	1.958	1.917	2.183	2.017	2.336	2.110	2.314		SUM
0.132	0.125	0.128	0.140	0.147	0.156	0.155	0.167	0.162	0.165		MEAN
0.133	0.123	0.121	0.144	0.151	0.164	0.158	0.168	0.161	0.170		MEDIAN
0.022903	0.019321	0.019386	0.02714	0.021716	0.022946	0.025579	0.023409	0.024794	0.029663		STDVA

B-BASIS ONE SIDED STATISTICAL TOLERANCE INTERVAL (one Sided is better fit to data)

(with 95% conf for 90 & 95% of population)

0.179946	0.165462	0.168385	0.197096	0.193261	0.204322	0.209101	0.216227	0.214598	0.227846		Kmax-90%
0.08334	0.083967	0.086615	0.082618	0.101662	0.107535	0.101207	0.117488	0.110018	0.102726		Kmin-90%
0.191512	0.175219	0.178174	0.210802	0.204228	0.21591	0.222018	0.228048	0.227119	0.242826		Kmax-95%
0.071774	0.074209	0.076826	0.068913	0.090695	0.095947	0.088289	0.105666	0.097497	0.087746		Kmin-95%
0.366923	0.326729	0.320663	0.409266	0.310589	0.310359	0.3477	0.295878	0.322166	0.378496		VARIANCE 90/95%

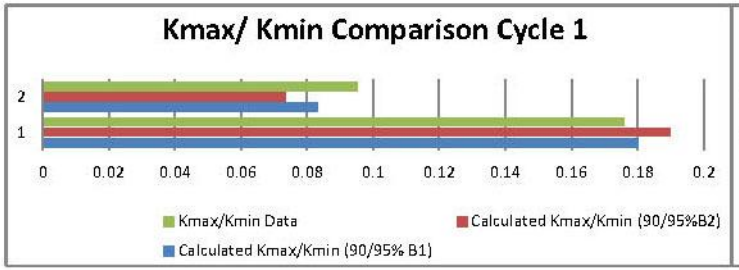
B-BASIS TWO SIDED STATISTICAL TOLERANCE INTERVAL

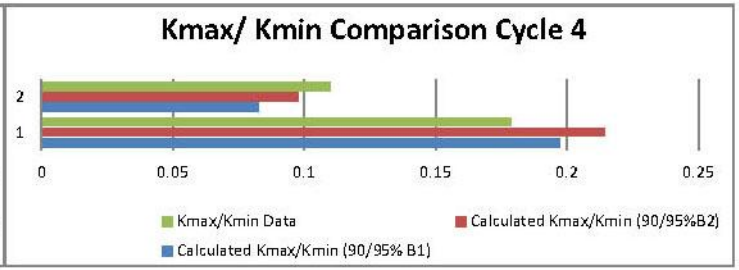
0.189863	0.173828	0.176779	0.208848	0.202665	0.214258	0.220177	0.226363	0.225333	0.24069		Kmax-90%
0.073423	0.075601	0.078221	0.070867	0.092258	0.097599	0.090131	0.107352	0.099282	0.089882		Kmin-90%
0.200902	0.183141	0.186123	0.221929	0.213132	0.225318	0.232506	0.237646	0.237284	0.254988		Kmax-95%
0.062384	0.066288	0.068877	0.057785	0.081791	0.086539	0.077802	0.096069	0.087331	0.075584		Kmin-95%
0.442256	0.39381	0.386499	0.493293	0.374356	0.374078	0.419087	0.356625	0.38831	0.456205		VARIANCE 90/95%

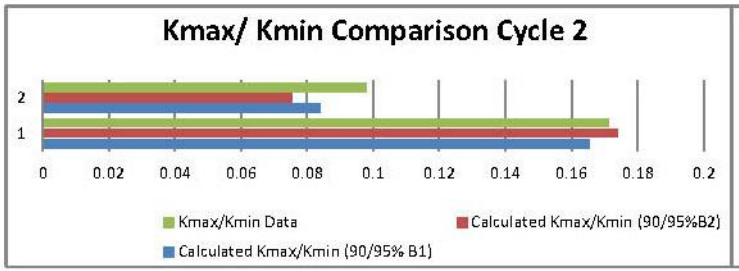
Note: If measured **values for Kmax & Kmin are bracketed by the calculated B-basis values, the calculated maximum and minimum preloads are conservative.**

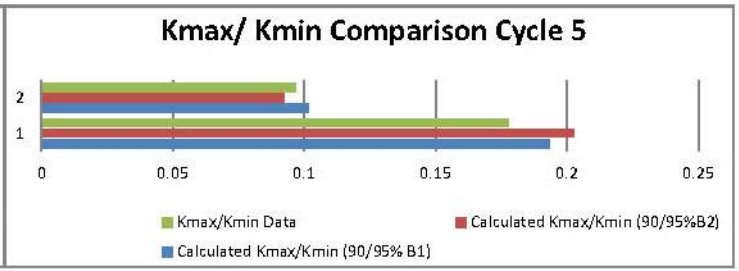
ie. Kmin (B-basis) < Kmin (data) - will result in maximum calculated preload exceeding that based on data, ie. conservative margin to yield.

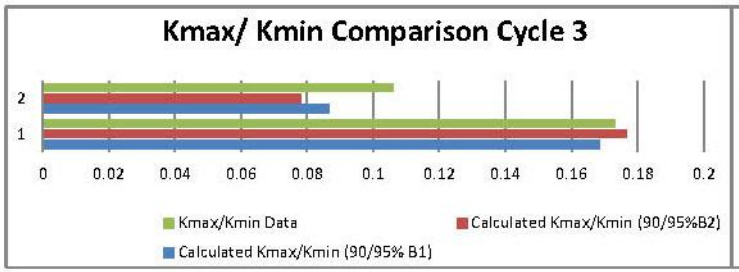
Kmax (B-basis) > Kmax (data) - will result in minimum calculated preload being less than that based on data, ie. conservative seperation margin.

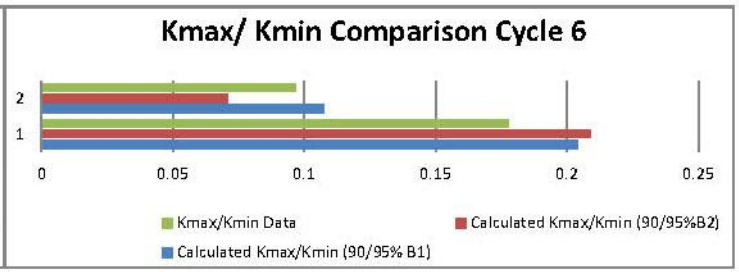


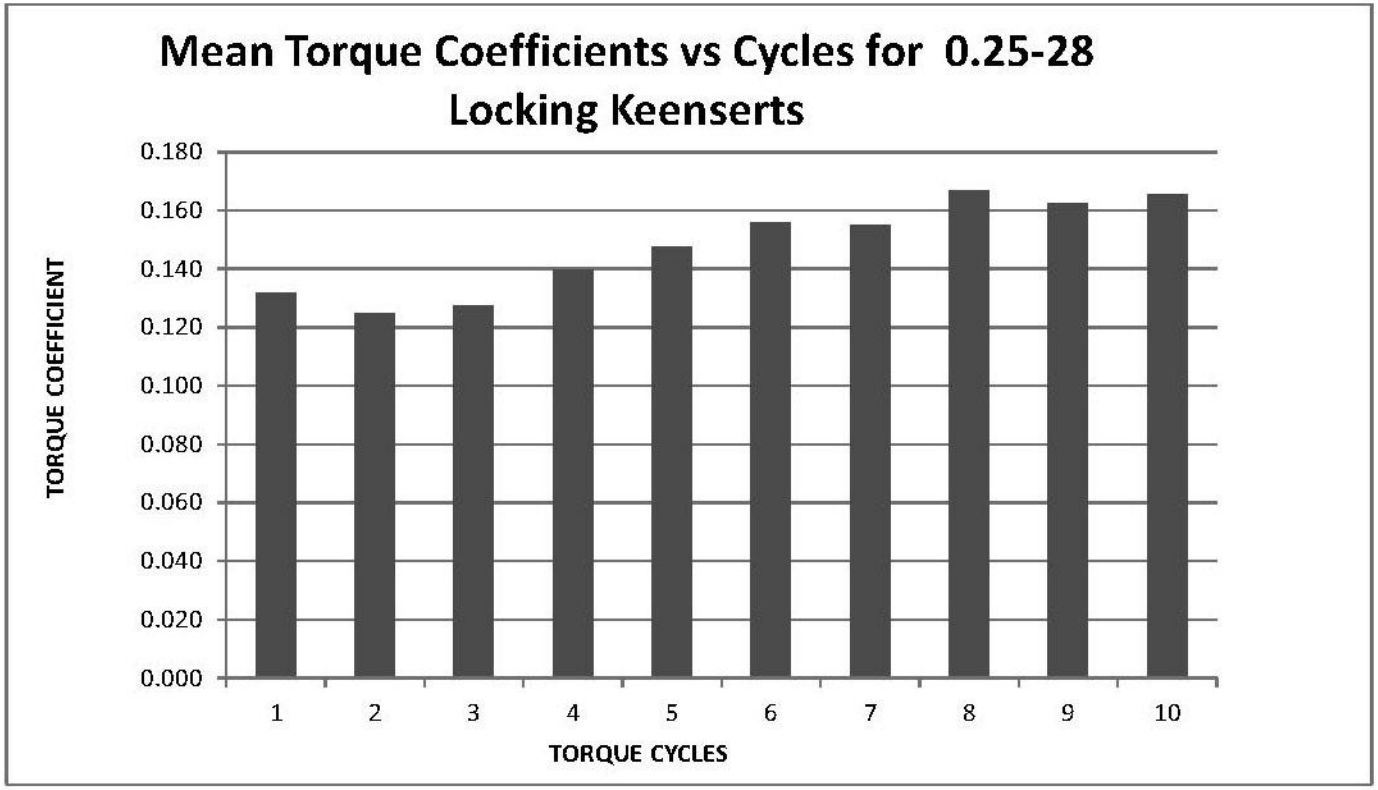


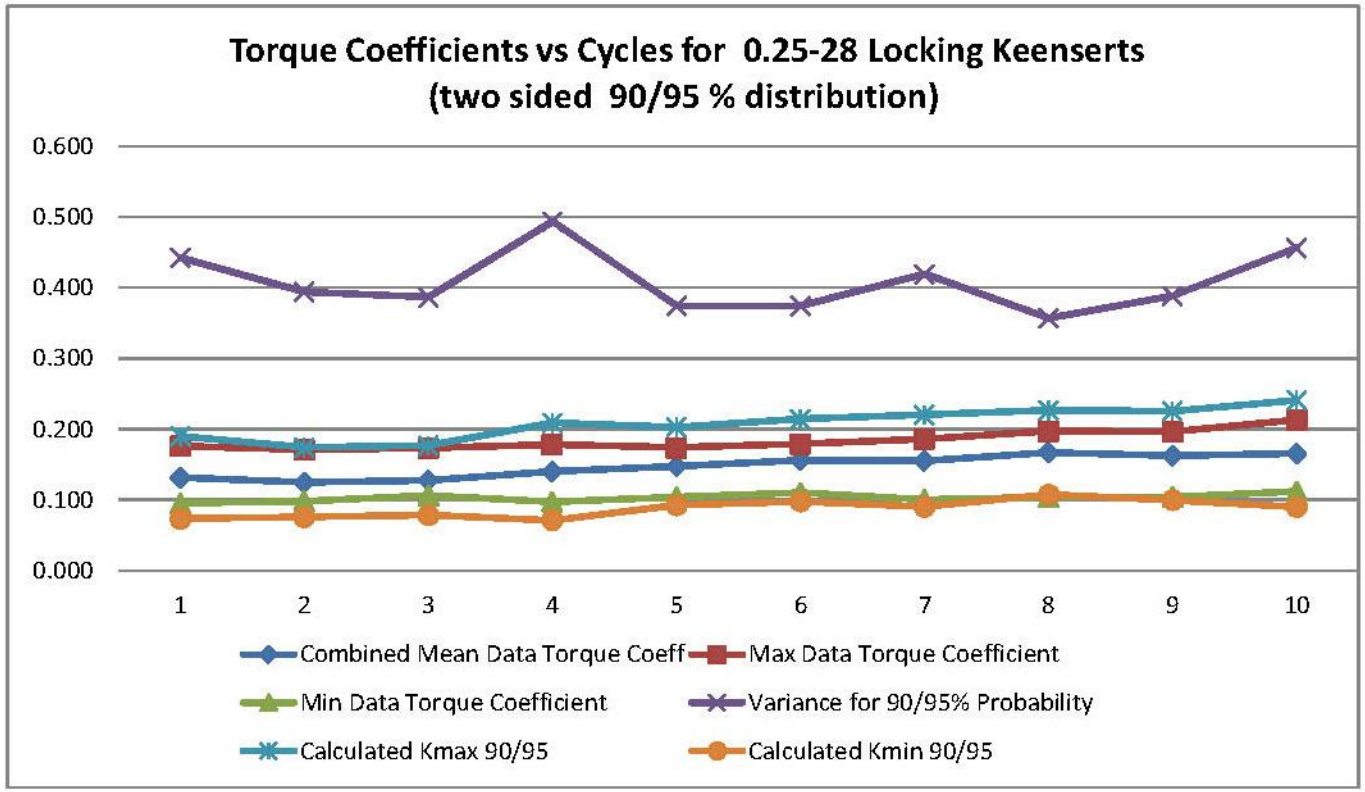


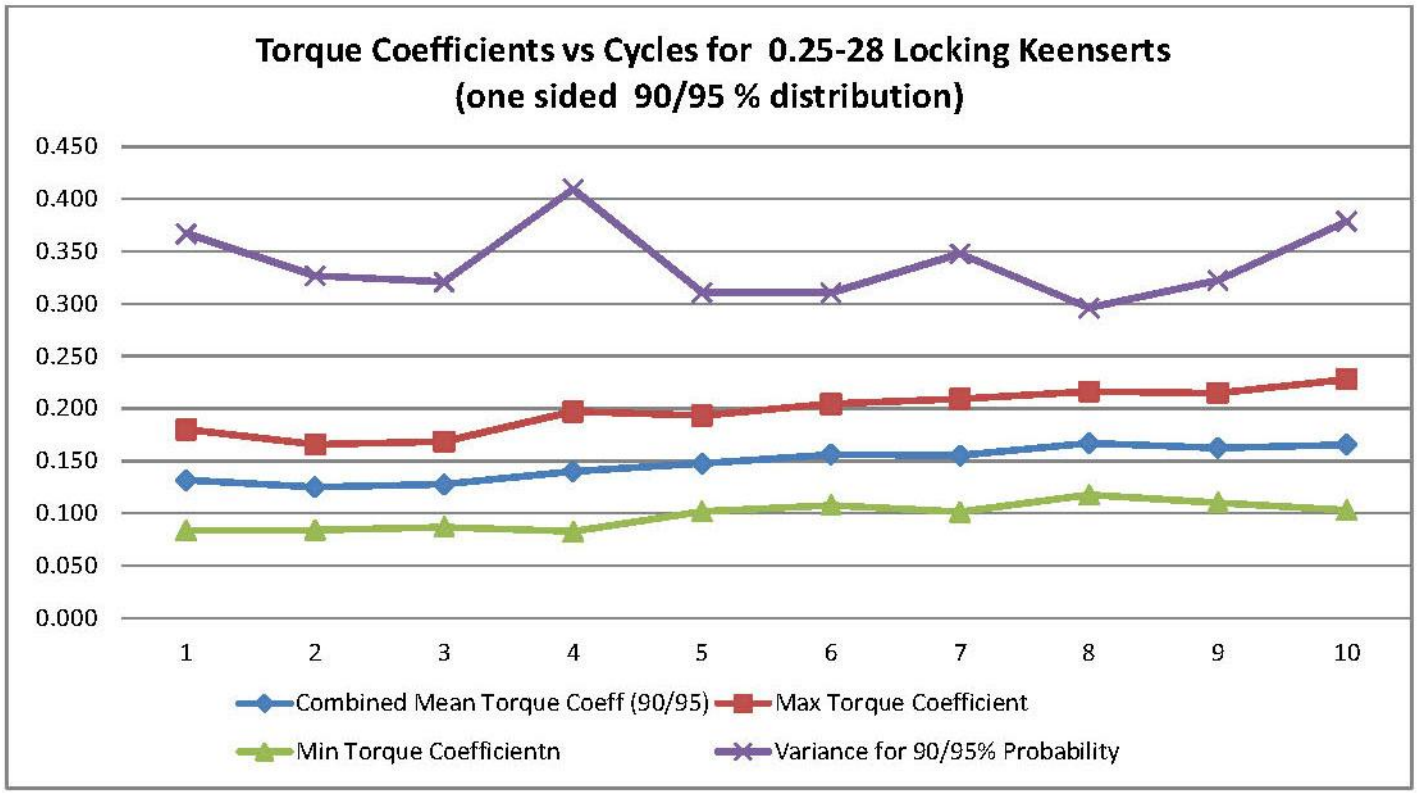







Mean Torque Coefficients vs Cycles for 0.25-28 Locking Keenserts
TORQUE COEFFICIENT
0.180
0.160
0.140
0.120
0.100
0.080
0.060
0.040
0.020
0.000
1
2
3
4
5
6
7
8
9
10
TORQUE CYCLES


Torque Coefficients vs Cycles for 0.25-28 Locking Keenserts
(two sided 90/95 % distribution)
0.600
0.500
0.400
0.300
0.200
0.100
0.000
1
2
3
4
5
6
7
8
9
10
Combined Mean Data Torque Coeff
Max Data Torque Coefficient
Min Data Torque Coefficient
Variance for 90/95% Probability
Calculated Kmax 90/95
Calculated Kmin 90/95


Torque Coefficients vs Cycles for 0.25-28 Locking Keenserts
(one sided 90/95 % distribution)
0.450
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
1
2
3
4
5
6
7
8
9
10
Combined Mean Torque Coeff (90/95)
Max Torque Coefficient
Min Torque Coefficientn
Variance for 90/95% Probability

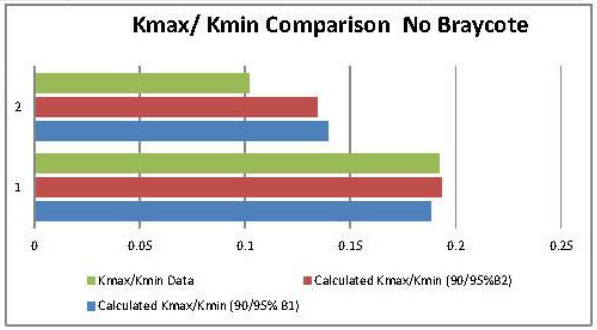
(Super Koropon Lube bolt head and washer, As Received Hardware, no cleaning, running torque removed)

TEST RUN NUMBER	TEST CYCLES INTO LOCKING EXHD KEENSERTS 1	2	3	4	5	6	7	8	9	10	INSERT #	Lube/Insert Type
1	0.176	0.171	0.173	0.169		0.172		0.162		0.192	1	ExHD No Braycote
17	0.153	0.148	0.140	0.178	0.157	0.174	0.146	0.150	0.149	0.170	2	ExHD No Braycote
67	0.111	0.107	0.110	0.102	0.104	0.110	0.111	0.170	0.165	0.168	7	HD No Braycote
77	0.131	0.131	0.138	0.144	0.149	0.178	0.178	0.185	0.132	0.122	8	HD No Braycote

2.780		SUM ExHD	
0.164		AVE ExHD	
0.169		MED ExHD	
0.0142		STDVA ExHD	
0.187911		Kmax 90/95 B1	
0.139148		Kmin 90/95 B1	
0.192		Max Test	
0.102		Min Test	
0.193023		Kmax 90/95 B2	
0.134036		Kmin 90/95 B2	

Friction Factors for ExHD & HD Keensерts, no Braycote, n=37

	Calculated values based on 90/95% Probability B-basis one sided	B-Basis two sided	Test Based Measured values
Kmax	0.188	0.193	0.192
Kmin	0.139	0.134	0.102



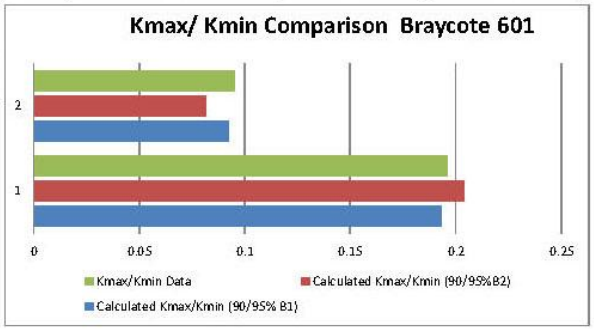
(Super Koropon Lube bolt head and washer, As Received Hardware, no cleaning, running torque removed)

TEST RUN NUMBER	TEST CYCLES INTO LOCKING EXHD KEENSERTS 1	2	3	4	5	6	7	8	9	10	INSERT #	Lube/Insert Type
47	0.138	0.117	0.106	0.131	0.107	0.113	0.100	0.104	0.104	0.121	3	ExHD Braycote 601
57	0.130	0.121	0.120	0.133	0.147	0.166	0.173	0.190	0.196	0.187	4	ExHD Braycote 601
97	0.105	0.105	0.109	0.161	0.174	0.173	0.172	0.192	0.182	0.193	10	HD Braycote 601
107	0.095	0.098	0.143	0.153	0.160	0.155	0.153	0.154	0.155	0.154	11	HD Braycote 601
117	0.106	0.113	0.120	0.160	0.158	0.166	0.168	0.173	0.178	0.112	12	HD Braycote 601

7.144		SUM ExHD	
0.143		AVE ExHD	
0.150		MED ExHD	
0.030592		STDVA ExHD	
0.193234		Kmax 90/95 B1	
0.092526		Kmin 90/95 B1	
0.196		Max Test	
0.095		Min Test	
0.204033		Kmax 90/95 B2	
0.081727		Kmin 90/95 B2	

Friction Factors for ExHD & HD Keensерts, Braycote 601, n=50

	Calculated values based on 90/95% Probability B-basis one sided	B-Basis two sided	Test Based Measured values
Kmax	0.193	0.204	0.196
Kmin	0.093	0.082	0.095



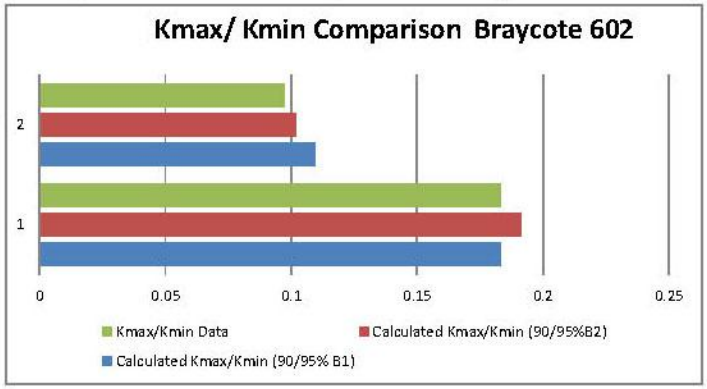
(Super Koropon Lube bolt head and washer, As Received Hardware, no cleaning, running torque removed)

TEST RUN NUMBER	TEST CYCLES INTO LOCKING EXHD KEENSERTS 1	2	3	4	5	6	7	8	9	10	INSERT #	Lube/Insert Type	
27	0.159	0.131	0.113	0.109	0.163	0.162	0.175	0.177	0.175	0.183	5	ExHD Braycote 602	
37	0.135	0.112	0.121	0.108	0.140	0.147	0.144	0.158	0.161	0.160	6	ExHD Braycote 602	
127	0.148	0.142	0.150	0.144	0.135	0.130	0.153	0.159	0.161	0.169	13	HD Braycote 602	
137	0.137	0.124	0.110	0.097	0.151	0.158	0.158	0.165	0.160	0.170	14	HD Braycote 602	

5.854		SUM ExHD	
0.146		AVE ExHD	
0.151		MED ExHD	
0.021752		STDVA ExHD	
0.183263		Kmax 90/95 B1	
0.109437		Kmin 90/95 B1	
0.183		Max Test	
0.097		Min Test	
0.191051		Kmax 90/95 B2	
0.101649		Kmin 90/95 B2	

Friction Factors for ExHD & HD Keenserts, Braycote 602, n=40

	Calculated values based on 90/95% Probability		Test Based
	B-basis one sided	B-Basis two sided	Measured values
Kmax	0.183	0.191	0.183
Kmin	0.109	0.102	0.102



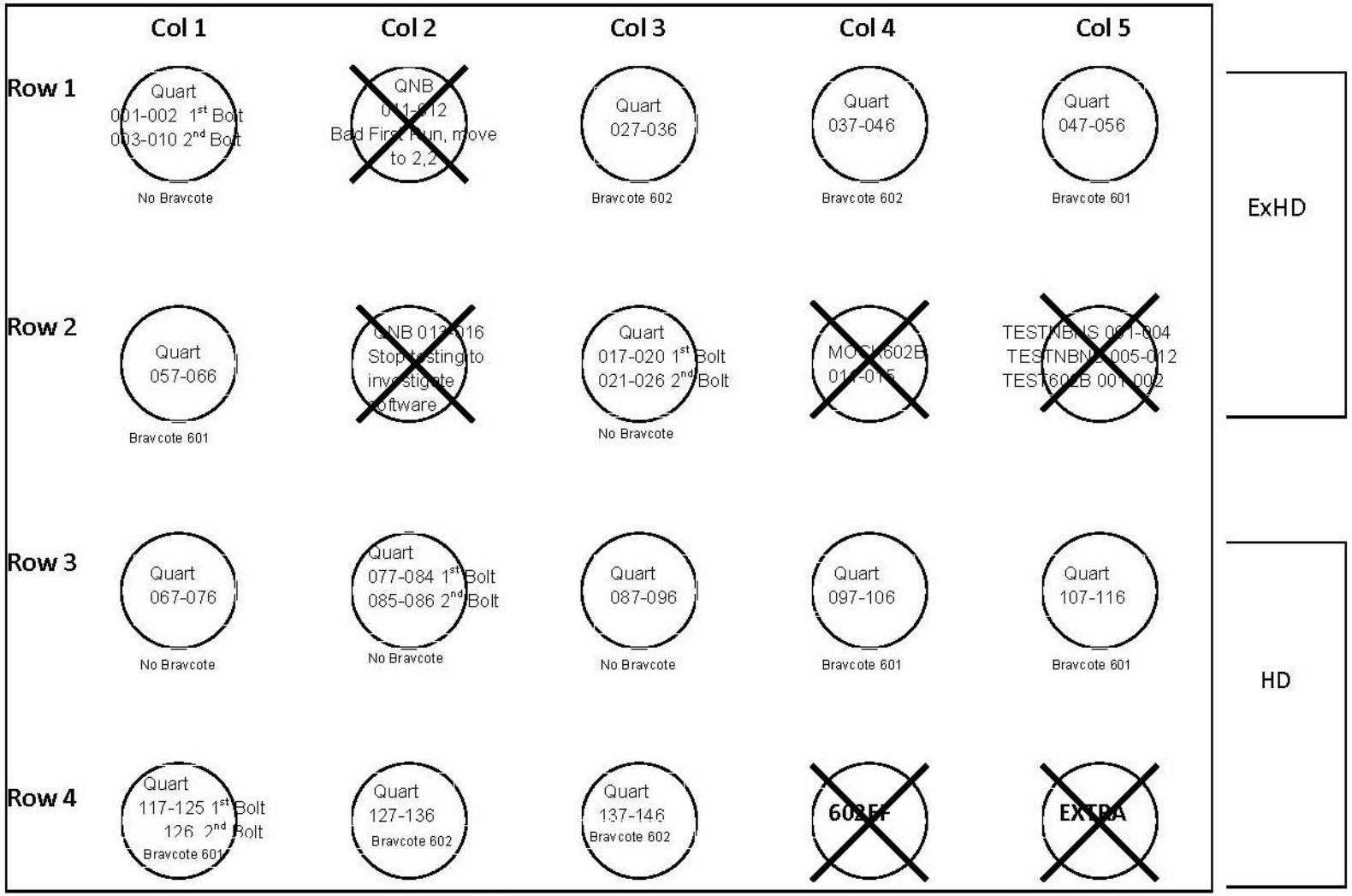
Note: If measured **values for Kmax & Kmin bracket the calculated B-basis values, calculated maximum and minimum preloads are conservative.**

ie. Maximum B-basis preload based on Kmin, will exceed actual based on data since Kmin data is greater.
Likewise minimum B-basis preload based on Kmax, will be less than actual based on data since Kmax data is less.

Appendix D:

Section 1	1/4-28 No Braycote Torque Tension Plots
Section 2	1/4-28 Braycote 601 Torque Tension Plots
Section 3	1/4-28 Braycote 602 Torque Tension Plots
Section 4	1/4-28 No Braycote Running Torque Plots
Section 5	1/4-28 Braycote 601 Running Torque Plots
Section 6	1/4-28 Braycote 602 Running Torque Plots
Section 7	1/4-28 No Braycote Cycle Plots: Torque v. Load
Section 8	1/4-28 Braycote 601 Cycle Plots: Torque v. Load
Section 9	1/4-28 Braycote 602 Cycle Plots: Torque v. Load
Section 10	1/4-28 Friction Coefficients with Statistics
Section 11	1/4-28 Test Plate Layouts
Section 12	1/4-28 No Braycote Run Log
Section 13	1/4-28 Braycote 601 Run Logs
Section 14	1/4-28 Braycote 602 Run Logs

¼ -28 Fastener Plate Layout (Not to Scale)



ExHD = Extra Heavy Duty Inserts (Row 1&2) : MS51832CA202L : Lot No. 232019; [Batch No. 404556]

HD = Heavy Duty Inserts (Row 3&4) : MS51831CA202L : Lot No. 230976; [Batch No. 412206]

Appendix D:

Section 1	1/4-28 No Braycote Torque Tension Plots
Section 2	1/4-28 Braycote 601 Torque Tension Plots
Section 3	1/4-28 Braycote 602 Torque Tension Plots
Section 4	1/4-28 No Braycote Running Torque Plots
Section 5	1/4-28 Braycote 601 Running Torque Plots
Section 6	1/4-28 Braycote 602 Running Torque Plots
Section 7	1/4-28 No Braycote Cycle Plots: Torque v. Load
Section 8	1/4-28 Braycote 601 Cycle Plots: Torque v. Load
Section 9	1/4-28 Braycote 602 Cycle Plots: Torque v. Load
Section 10	1/4-28 Friction Coefficients with Statistics
Section 11	1/4-28 Test Plate Layouts
Section 12	1/4-28 No Braycote Run Log
Section 13	1/4-28 Braycote 601 Run Logs
Section 14	1/4-28 Braycote 602 Run Logs

Orion NESC Torque Tension Run Log

Date: 7/8/2011
Time: 3:07PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.1,20,50.5
Temperature(ºF): Start/End of Day: 74.4/
Humidity(%): Start/End of Day: 47/

Tor Wrench Op: Mcleod
Data Sys. Op: Peil
Notes: FilenamePrefix: Quart 001-010 (QNB 001-010)
Fastener Spec: NAS6704U12
Washer Spec: NAS1587-4C
The torque wrench has a in-lb capacity
calibrated out to 300 in-lb
Torque Wrench: S/N: 9644

Run No.	Cord	Cycle No.	Fastener Size	Target Load (lb)	Brk Torq (In-lb)	Lubrication Type			Comments	Breakaway Running Torq (In-lb)
						None	Braycote			
							601	602		
1	1,1	1	1/4-28	2857	106	X			torque wrench slip, not operator	~2.5
2	1,1	2	1/4-28	2857	114	X			running torque not met. NEW BOLT	~2
3	1,1	3	1/4-28	2857	110	X			50 points not acquired	~1
4	1,1	4	1/4-28	2857	109	X				~1
5	1,1	5	1/4-28	2857	115	X				~1
6	1,1	6	1/4-28	2857	115	X				~.5
7	1,1	7	1/4-28	2857	116	X			slight over torque on bolt after acq stop, 42 pts collected	~.5
8	1,1	8	1/4-28	2857	111	X				~.5
9	1,1	9	1/4-28	2857	116	X			48 pts acquired	~.5
10	1,1	10	1/4-28	2857	116	X				~.5

Orion NESC Torque Tension Run Log

Date: 7/15/2011
Time: 10:55 AM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.1,20,50.5
Temperature(°F): Start/End of Day: 74.4/
Humidity(%): Start/End of Day: 47/

Tor Wrench Op: Penderghest
Data Sys. Op: Peil
Notes: FilenamePrefix: QNB 011-012, 013-022
Fastener Spec: NAS6704U12
Washer Spec: NAS1587-4C
The torque wrench has a in-lb capacity
calibrated out to 300 in-lb
Torque Wrench: S/N: 9644

Run No.	Cord	Cycle No.	Fastener Size	Target Load (lb)	Brk Torq (In-lb)	Lubrication Type			Comments	Breakaway Running Torq (In-lb)
						None	Braycote			
							601	602		
1	1,2	1	1/4-28	2857	100	X			23 data points	~4.5
2	1,2	2	1/4-28	2857	110	X			stop testing on this insert and move to new location	~5
3						X				
4	2,2	1	1/4-28	2857	100	X			37 data points	~6
5	2,2	2	1/4-28	2857	120	X			21 data points	~4
6	2,2	3	1/4-28	2857	140	X				~4
7	2,2	4	1/4-28	2857	125	X			33 data points, stop testing for the day to review issue in software	3.5
8						X				
9						X				
10						X				

***This data is unreliable and will not be used in data set**

*** Load Cells and Torque Wrench changed to 5000Hz sample rate in software 7/20/11**

Orion NESC Torque Tension Run Log

Date: 7/22/2011
Time: 9:30 AM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5,1, 20.1, 49.5
Temperature(ºF): Start/End of Day: 76.1/75.5
Humidity(%): Start/End of Day: 46/47

Tor Wrench Op:
Data Sys. Op: Peil
Notes: FilenamePrefix: Quart 017-026 (QNB 017-026)
Fastener Spec: NAS6704U12
Washer Spec: NAS1587-4C
The torque wrench has a in-lb capacity
calibrated out to 300 in-lb
Torque Wrench: S/N: 9644

Run No.	Cord	Cycle No.	Fastener Size	Target Load (lb)	Brk Torq (In-lb)	Lubrication Type			Comments	Breakaway Running Torq (In-lb)
						None	Braycote			
							601	602		
1	2,3	1	1/4-28	2857	95	X				~5
2	2,3	2	1/4-28	2857	85	X				~4
3	2,3	3	1/4-28	2857	80	X			running torque below 3.5 in-lb	~2
4	2,3	4	1/4-28	2857	100	X			new bolt this run	~3.5
5	2,3	5	1/4-28	2857	100	X				~2
6	2,3	6	1/4-28	2857	78	X				~2
7	2,3	7	1/4-28	2857	80	X				~2
8	2,3	8	1/4-28	2857	85	X				~1
9	2,3	9	1/4-28	2857	95	X				~1
10	2,3	10	1/4-28	2857	107	X				~1

Orion NESC Torque Tension Run Log

Date: 7/26/2011
Time: 11:28 AM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.0, 20.1,49.9
Temperature(°F): Start/End of Day: 66.9/67.1
Humidity(%): Start/End of Day: 60/60

Tor Wrench Op: Peil
Data Sys. Op:
Notes: FilenamePrefix: Quart 067-076 (QNB 027-036)
Fastener Spec: NAS6704U12
Washer Spec: NAS1587-4C
The torque wrench has a in-lb capacity
calibrated out to 300 in-lb
Torque Wrench: S/N: 9644

Run No.	Cord	Cycle No.	Fastener Size	Target Load (lb)	Brk Torq (In-lb)	Lubrication Type			Comments	Breakaway Running Torq (In-lb)
						None	Braycote 601	Braycote 602		
1	1,3	1	1/4-28	2857	70	X				9.5
2	1,3	2	1/4-28	2857	61	X				5.75
3	1,3	3	1/4-28	2857	56	X				5
4	1,3	4	1/4-28	2857	50	X				4.75
5	1,3	5	1/4-28	2857	55	X				4.25
6	1,3	6	1/4-28	2857	51	X				4.25
7	1,3	7	1/4-28	2857	56	X				4
8	1,3	8	1/4-28	2857	recor	X				4
9	1,3	9	1/4-28	2857	95	X			no apparent reason for jump in break torque	4
10	1,3	10	1/4-28	2857	100	X				4.25

Orion NESC Torque Tension Run Log

Date: 7/26/2011
Time: 1:26 PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.0, 20.1,49.9
Temperature(ºF): Start/End of Day: 67.2/67.6
Humidity(%): Start/End of Day: 62/59

Tor Wrench Op: Mcleod
Data Sys. Op: Peil
Notes: FilenamePrefix: Quart 077-086 (QNB 037-046)
Fastener Spec: NAS6704U12
Washer Spec: NAS1587-4C
The torque wrench has a in-lb capacity
calibrated out to 300 in-lb
Torque Wrench: S/N: 9644

Run No.	Cord	Cycle No.	Fastener Size	Target Load (lb)	Brk Torq (In-lb)	Lubrication Type			Comments	Breakaway Running Torq (In-lb)
						None	Braycote 601	Braycote 602		
1	1,4	1	1/4-28	2857	85	X				8.5
2	1,4	2	1/4-28	2857	77	X				5.5
3	1,4	3	1/4-28	2857	80	X				4.5
4	1,4	4	1/4-28	2857	95	X				5
5	1,4	5	1/4-28	2857	92.5	X				4
6	1,4	6	1/4-28	2857	113	X				3.5
7	1,4	7	1/4-28	2857	115	X				3
8	1,4	8	1/4-28	2857	117	X			running torque not met, **use a new bolt/washer next run**	2.5
9	1,4	9	1/4-28	2857	87	X			significantly higher running torque	7.5
10	1,4	10	1/4-28	2857	75	X				6

Orion NESC Torque Tension Run Log

Date: 7/26/2011
Time: 2:37 PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.0, 20.1,49.9
Temperature(ºF): Start/End of Day: 67.6/67.8
Humidity(%): Start/End of Day: 59/58

Tor Wrench Op: Mcleod
Data Sys. Op: Peil
Notes: FilenamePrefix: Quart 087-096 (QNB 047-056)
Fastener Spec: NAS6704U12
Washer Spec: NAS1587-4C
The torque wrench has a in-lb capacity
calibrated out to 300 in-lb
Torque Wrench: S/N: 9644

Run No.	Cord	Cycle No.	Fastener Size	Target Load (lb)	Brk Torq (In-lb)	Lubrication Type			Comments	Breakaway Running Torq (In-lb)
						None	Braycote			
							601	602		
1	1,5	1	1/4-28	2857	82	X				13.5
2	1,5	2	1/4-28	2857	78	X				8.2
3	1,5	3	1/4-28	2857	82	X				5
4	1,5	4	1/4-28	2857	103	X				4.6
5	1,5	5	1/4-28	2857	113	X				4.1
6	1,5	6	1/4-28	2857	115	X				3.9
7	1,5	7	1/4-28	2857	119	X				3.9
8	1,5	8	1/4-28	2857	125	X				3.9
9	1,5	9	1/4-28	2857	127	X				4.5
10	1,5	10	1/4-28	2857	130	X				3.9

Appendix D:

Section 1	1/4-28 No Braycote Torque Tension Plots
Section 2	1/4-28 Braycote 601 Torque Tension Plots
Section 3	1/4-28 Braycote 602 Torque Tension Plots
Section 4	1/4-28 No Braycote Running Torque Plots
Section 5	1/4-28 Braycote 601 Running Torque Plots
Section 6	1/4-28 Braycote 602 Running Torque Plots
Section 7	1/4-28 No Braycote Cycle Plots: Torque v. Load
Section 8	1/4-28 Braycote 601 Cycle Plots: Torque v. Load
Section 9	1/4-28 Braycote 602 Cycle Plots: Torque v. Load
Section 10	1/4-28 Friction Coefficients with Statistics
Section 11	1/4-28 Test Plate Layouts
Section 12	1/4-28 No Braycote Run Log
Section 13	1/4-28 Braycote 601 Run Logs
Section 14	1/4-28 Braycote 602 Run Logs

Orion NESC Torque Tension Run Log

Date: 7/22/2011
Time: 2:01 PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5,1, 20.1, 49.5 5
Temperature(°F): Start/End of Day: 75.5/75.3
Humidity(%): Start/End of Day: 47/48

Tor Wrench Op: Peil
Data Sys. Op: Goodman
Notes: FilenamePrefix: Quart 047-056 (Q601B 001-010)
Fastener Spec: NAS6704U12
Washer Spec: NAS1587-4C
The torque wrench has a in-lb capacity
calibrated out to 300 in-lb
Torque Wrench: S/N: 9644

Run No.	Cord	Cycle No.	Fastener Size	Target Load (lb)	Brk Torq (In-lb)	Lubrication Type			Comments	Breakaway Running Torq (In-lb)
						None	Braycote			
							601	602		
1	1,5	1	1/4-28	2857	77		X			4
2	1,5	2	1/4-28	2857	60		X			3.5
3	1,5	3	1/4-28	2857	51		X		Running torque did not exceed 3.5 in.-lb.	3
4	1,5	4	1/4-28	2857	71		X		New bolt used for this run.	3.5
5	1,5	5	1/4-28	2857	52		X			3
6	1,5	6	1/4-28	2857	64		X			2.5
7	1,5	7	1/4-28	2857	51		X			2.5
8	1,5	8	1/4-28	2857	57		X			2.25
9	1,5	9	1/4-28	2857	55		X			2
10	1,5	10	1/4-28	2857	62		X			2

Orion NESC Torque Tension Run Log

Date: 7/26/2011
Time: 10:30 AM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.0, 20.1,49.9
Temperature(ºF): Start/End of Day: 66.7/66.9
Humidity(%): Start/End of Day: 59/60

Tor Wrench Op: Peil
Data Sys. Op:
Notes: FilenamePrefix: Quart 057-066 (Q601B 011-020)
Fastener Spec: NAS6704U12
Washer Spec: NAS1587-4C
The torque wrench has a in-lb capacity
calibrated out to 300 in-lb
Torque Wrench: S/N: 9644

Run No.	Cord	Cycle No.	Fastener Size	Target Load (lb)	Brk Torq (In-lb)	Lubrication Type			Comments	Breakaway Running Torq (In-lb)
						None	Braycote			
							601	602		
1	2,1	1	1/4-28	2857	77		X			12.5
2	2,1	2	1/4-28	2857	62.5		X			7
3	2,1	3	1/4-28	2857	72		X			5
4	2,1	4	1/4-28	2857	75		X			4
5	2,1	5	1/4-28	2857	74		X			3.75
6	2,1	6	1/4-28	2857	97		X			3.75
7	2,1	7	1/4-28	2857	105		X			3.75
8	2,1	8	1/4-28	2857	111		X			3.75
9	2,1	9	1/4-28	2857	109		X			3.5
10	2,1	10	1/4-28	2857	107		X			3.5

Orion NESC Torque Tension Run Log

Date: 7/26/2011
Time: 3:35 PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.0, 20.1,49.9
Temperature(°F): Start/End of Day: 67.8/68.1
Humidity(%): Start/End of Day: 58/58

Tor Wrench Op: Mcleod
Data Sys. Op: Peil
Notes: FilenamePrefix: Quart 097-106 (Q601B 021-030)
Fastener Spec: NAS6704U12
Washer Spec: NAS1587-4C
The torque wrench has a in-lb capacity
calibrated out to 300 in-lb
Torque Wrench: S/N: 9644

Run No.	Cord	Cycle No.	Fastener Size	Target Load (lb)	Brk Torq (In-lb)	Lubrication Type			Comments	Breakaway Running Torq (In-lb)
						None	Braycote			
							601	602		
1	3,4	1	1/4-28	2857	66		X			15.5
2	3,4	2	1/4-28	2857	62.5		X			12.8
3	3,4	3	1/4-28	2857	62.5		X			11
4	3,4	4	1/4-28	2857	105		X		no apparent reason for jump in break torque	8
5	3,4	5	1/4-28	2857	113		X			7.1
6	3,4	6	1/4-28	2857	116		X			6.8
7	3,4	7	1/4-28	2857	116		X			5.4
8	3,4	8	1/4-28	2857	123		X			5
9	3,4	9	1/4-28	2857	128		X			5
10	3,4	10	1/4-28	2857	131		X			5

Orion NESC Torque Tension Run Log

Date: 7/27/2011
Time: 8:20 PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.2,20.2,,50.3
Temperature(°F): Start/End of Day: 66/66.3
Humidity(%): Start/End of Day: 61/59

Tor Wrench Op: Peil
Data Sys. Op: Goodman
Notes: FilenamePrefix: Quart 107-116 (Q601B 031-040)
Fastener Spec: NAS6704U12
Washer Spec: NAS1587-4C
The torque wrench has a in-lb capacity
calibrated out to 300 in-lb
Torque Wrench: S/N: 9644

Run No.	Cord	Cycle No.	Fastener Size	Target Load (lb)	Brk Torq (In-lb)	Lubrication Type			Comments	Breakaway Running Torq (In-lb)
						None	Braycote			
							601	602		
1	3,5	1	1/4-28	2857	61		X			12.4
2	3,5	2	1/4-28	2857	56.5		X			10
3	3,5	3	1/4-28	2857	86		X			8.4
4	3,5	4	1/4-28	2857	97.5		X			7
5	3,5	5	1/4-28	2857	92		X			5.9
6	3,5	6	1/4-28	2857	97.5		X			5.4
7	3,5	7	1/4-28	2857	96.5		X			4.9
8	3,5	8	1/4-28	2857	95.5		X			4.8
9	3,5	9	1/4-28	2857	95		X			4.6
10	3,5	10	1/4-28	2857	96.5		X			4.5

Orion NESC Torque Tension Run Log

Date: 7/27/2011
Time: 9:40AM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.2,20.2,50.3
Temperature(°F): Start/End o 66.3/66.7
Humidity(%): Start/End o 59/59

Tor Wrench Op: Peil
Data Sys. Op: Goodman
Notes: FilenamePrefix: Quart 117-126 (Q601B 041-050)
Fastener Spec: NAS6704U12
Washer Spec: NAS1587-4C
The torque wrench has a in-lb capacity
calibrated out to 300 in-lb
Torque Wrench: S/N: 9644

Run No.	Cord	Cycle No.	Fastener Size	Target Load (lb)	Brk Torq (In-lb)	Lubrication Type			Comments	Breakaway Running Torq (In-lb)
						None	Braycote			
							601	602		
1	4,1	1	1/4-28	2857	68		X			10.5
2	4,1	2	1/4-28	2857	75		X			7
3	4,1	3	1/4-28	2857	72		X			5.6
4	4,1	4	1/4-28	2857	90.5		X			4.6
5	4,1	5	1/4-28	2857	102		X			4
6	4,1	6	1/4-28	2857	106		X			3.2
7	4,1	7	1/4-28	2857	112		X			2.9
8	4,1	8	1/4-28	2857	117		X			2.7
9	4,1	9	1/4-28	2857	130		X		Running torque not met.New bolt for cycle 10.	2.75
10	4,1	10	1/4-28	2857	79.5		X			5.4

Appendix D:

Section 1	1/4-28 No Braycote Torque Tension Plots
Section 2	1/4-28 Braycote 601 Torque Tension Plots
Section 3	1/4-28 Braycote 602 Torque Tension Plots
Section 4	1/4-28 No Braycote Running Torque Plots
Section 5	1/4-28 Braycote 601 Running Torque Plots
Section 6	1/4-28 Braycote 602 Running Torque Plots
Section 7	1/4-28 No Braycote Cycle Plots: Torque v. Load
Section 8	1/4-28 Braycote 601 Cycle Plots: Torque v. Load
Section 9	1/4-28 Braycote 602 Cycle Plots: Torque v. Load
Section 10	1/4-28 Friction Coefficients with Statistics
Section 11	1/4-28 Test Plate Layouts
Section 12	1/4-28 No Braycote Run Log
Section 13	1/4-28 Braycote 601 Run Logs
Section 14	1/4-28 Braycote 602 Run Logs

Orion NESC Torque Tension Run Log

Date: 7/22/2011
Time: 11:10 AM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5,1, 20.1, 49.5
Temperature(°F): Start/End of Day: 75.5/75.3
Humidity(%): Start/End of Day: 47/48

Tor Wrench Op:
Data Sys. Op: Peil
Notes: FilenamePrefix: Quart 027-036 (Q602B 001-010)
Fastener Spec: NAS6704U12
Washer Spec: NAS1587-4C
The torque wrench has a in-lb capacity
calibrated out to 300 in-lb
Torque Wrench: S/N: 9644

Run No.	Cord	Cycle No.	Fastener Size	Target Load (lb)	Brk Torq (In-lb)	Lubrication Type			Comments	Breakaway Running Torq (In-lb)
						None	Braycote			
							601	602		
1	1,3	1	1/4-28	2857	90			X		~5
2	1,3	2	1/4-28	2857	70			X		~4
3	1,3	3	1/4-28	2857	67			X		~5
4	1,3	4	1/4-28	2857	52			X		~4.5
5	1,3	5	1/4-28	2857	90			X		~4
6	1,3	6	1/4-28	2857	95			X		~4.5
7	1,3	7	1/4-28	2857	104			X		~3.5
8	1,3	8	1/4-28	2857	105			X		~3.5
9	1,3	9	1/4-28	2857	105			X		~4
10	1,3	10	1/4-28	2857	107			X		~4

Orion NESC Torque Tension Run Log

Date: 7/22/2011
Time: 1:06 PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5,1, 20.1, 49.5
Temperature(°F): Start/End of Day: 75.5/75.3
Humidity(%): Start/End of Day: 47/48

Tor Wrench Op: Peil
Data Sys. Op: Goodman
Notes: FilenamePrefix: Quart 037-046 (Q602B 011-020)
Fastener Spec: NAS6704U12
Washer Spec: NAS1587-4C
The torque wrench has a in-lb capacity
calibrated out to 300 in-lb
Torque Wrench: S/N: 9644

Run No.	Cord	Cycle No.	Fastener Size	Target Load (lb)	Brk Torq (In-lb)	Lubrication Type			Comments	Breakaway Running Torq (In-lb)
						None	Braycote			
							601	602		
1	1,4	1	1/4-28	2857	80			X		7.5
2	1,4	2	1/4-28	2857	68			X		7
3	1,4	3	1/4-28	2857	71			X		7
4	1,4	4	1/4-28	2857	71			X		6
5	1,4	5	1/4-28	2857	85			X		5.5
6	1,4	6	1/4-28	2857	87			X		5.5
7	1,4	7	1/4-28	2857	90			X		5.5
8	1,4	8	1/4-28	2857	95			X		5
9	1,4	9	1/4-28	2857	100			X		5
10	1,4	10	1/4-28	2857	105			X		5

Orion NESC Torque Tension Run Log

Date: 7/27/2011
Time: 12:45 PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.2,20.2,50.3
Temperature(°F): Start/End o 67.1/67.4
Humidity(%): Start/End o 57/57

Tor Wrench Op: Mcleod
Data Sys. Op: Peil
Notes: FilenamePrefix: Quart 127-136 (Q602B 021-030)
Fastener Spec: NAS6704U12
Washer Spec: NAS1587-4C
The torque wrench has a in-lb capacity
calibrated out to 300 in-lb
Torque Wrench: S/N: 9644

Run No.	Cord	Cycle No.	Fastener Size	Target Load (lb)	Brk Torq (In-lb)	Lubrication Type			Comments	Breakaway Running Torq (In-lb)
						None	Braycote			
							601	602		
1	4,2	1	1/4-28	2857	107			X		17.5
2	4,2	2	1/4-28	2857	93			X		13.5
3	4,2	3	1/4-28	2857	97.5			X		9
4	4,2	4	1/4-28	2857	102			X		6.6
5	4,2	5	1/4-28	2857	87			X		5.5
6	4,2	6	1/4-28	2857	85			X		4.5
7	4,2	7	1/4-28	2857	92			X		4.1
8	4,2	8	1/4-28	2857	90			X		4
9	4,2	9	1/4-28	2857	97			X		3.5
10	4,2	10	1/4-28	2857	105			X		3.5

Orion NESC Torque Tension Run Log

*** New batch of Super Koropon used (consistency of "White Out" instead of honey)**

Date: 7/27/2011
Time: 1:30 PM
Weight Check
Actual(lb): 5.0, 20.0, 50.0
Measured(lb): 5.2,20.2,50.3
Temperature(ºF): Start/End o 67.6/67.8
Humidity(%): Start/End o 57/57

Tor Wrench Op: Mcleod
Data Sys. Op: Goodman
Notes: FilenamePrefix: Quart 137-146 (Q602B 031-040)
Fastener Spec: NAS6704U12
Washer Spec: NAS1587-4C
The torque wrench has a in-lb capacity
calibrated out to 300 in-lb
Torque Wrench: S/N: 9644

Run No.	Cord	Cycle No.	Fastener Size	Target Load (lb)	Brk Torq (In-lb)	Lubrication Type			Comments	Breakaway Running Torq (In-lb)
						None	Braycote			
							601	602		
1	4,3	1	1/4-28	2857	89			X	Fastener slipped inside insert.	11
2	4,3	2	1/4-28	2857	76			X		8.5
3	4,3	3	1/4-28	2857	65			X		7.5
4	4,3	4	1/4-28	2857	54			X		5.5
5	4,3	5	1/4-28	2857	96			X		4.8
6	4,3	6	1/4-28	2857	101			X		6
7	4,3	7	1/4-28	2857	102			X		4.1
8	4,3	8	1/4-28	2857	105			X		4
9	4,3	9	1/4-28	2857	107			X		4
10	4,3	10	1/4-28	2857	106			X		4

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14. ABSTRACT

The primary objective of this testing was to obtain torque tension data for the use of Super Koropon® Primer Base which was proposed for use on the Orion project. This compound is a corrosion inhibitor/sealer used on threaded fasteners and inserts as specified per NASA/JSC PRC-4004, Sealing of Joints and Faying Surfaces. Some secondary objectives of this testing, were to identify the effect on torque coefficient of several variables. This document contains the outcome of the testing.

15. SUBJECT TERMS
Corrosion Resistant Steel; Dry Film Lubricant; Torque coefficient; Threaded fasteners

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